NSWC TR 89-356

HAZARD CLASS/DIVISION 1.6: ARTICLES CONTAINING EXTREMELY INSENSITIVE DETONATING SUBSTANCES (EIDS)

BY MICHAEL M. SWISDAK, JR.

RESEARCH AND TECHNOLOGY DEPARTMENT

1 DECEMBER 1989

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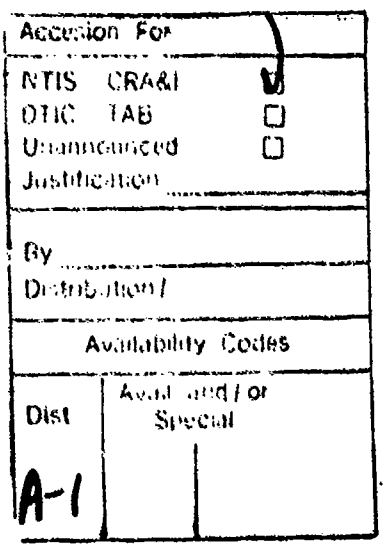

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FOREWORD

This task was performed for the Department of Defense Explosives Safety Board (DDESB), Code KT, under the cognizance of R. Sawyer and J. Ward.

The author wishes to acknowledge the following people in the performance of this task: (1) D. Tasker for the calibration of the Expanded Large Scale Gap Test (ELSGT) and the performance of the ELSGT on Composition B and PBX-9502; (2) D. Crabtree for the performance of the majority of the substance testing on Composition B and PBX-9502; (3) C. E. Coghill for the performance of the SUSAN Test on the French explosives (B3003, B3103, Octarane 86A); (4) R. Bernecker, C. Dickinson, and D. Price for their insights and comments during the development of the test protocol; (5) the Air Force Inspection and Safety Center (AFISC), the Military Airlift Command (MAC), and the personnel at Ramstein Air Force Base, Germany, for help in shipping explosive samples to and from France; and (6) the staff at the DDESB for allowing their files to be searched for information on the history of Class/Division 1.6 materials.

The mention of proprietary items or company names in this report is for technical information purposes only. No endorsement or criticism is intended.

Approved by:

Kurt F. Mueller

KURT F. MUELLER, Head
Energetic Materials Division

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CHAPTER 1

INTRODUCTION

The interest in Hazard Class/Division 1.5 within the Department of Defense (DOD) and the Department of Energy (DOE) dates back to the late 1970s. In its 1977 revision of its document on the Transport of Dangerous Goods[1] the United Nations (UN) Group of Experts on Explosives defined "very insensitive explosives" and limited them to Type B and E blasting agents (as defined in Reference 1).

In June 1979, the Air Force requested the Department of Defense Explosives Safety Board (DDESB) concurrence/approval for a Department of Transportation (DOT) hazard classification of 1.5L for Triaminotrinitrobenzene (TATB) and various TATB formulations. This represented the first instance of the UN Class 1.5 designation being sought for a DOD/DOE explosive. Shortly thereafter, the DDESB raised several technical questions regarding the application of the 1.5 classification to military materials. In order to resolve these questions, they proposed the following solution:[2]

> . . . It is suggested that the objective development of criteria for Hazard Division 1.5 could best be accomplished by a tri-Service working group with recognized expertise in evaluating explosive properties, such as the Joint Technical Coordinating Group for Munitions Development Working Party for Explosives, in cooperation with Service safety office representatives.

The DDESB further requested the Joint Technical Coordinating Group/Working Party for Explosives (JTCG/WPE):[3]

1. Review the UN Classification scheme for 1.5 materials and determine its applicability to DOD/DOE materials

2. Define the levels of sensitivity, response to stimuli, and effects on surroundings for Division 1.5 storage/operational applications

3. Recommend the minimum probabilities and confidence levels to be accepted in a Division 1.5 testing scheme

4. Express opinions as to whether sensitivity, reaction effects, or both should be the criteria used for reducing/eliminating quantity-distance requirements.

In February 1980, the Joint Technical Coordinating Group for Munitions Development: Working Party for Explosives (JTCG/MD/WPE) established an Ad Hoc Study Group to advise the DDESB and to determine a tri-Service position on the Hazard Classification 1.5 for explosive materials (high explosives, propellants,

pyrotechnics, etc.) and munitions containing these materials. The terms of reference for this group included:

1. Define the criteria to be used to establish the 1.5 Classification Criteria for military explosives and munitions

2. Study other issues arising from the introduction of the UN classification scheme, as required.

The official title of the Group was the Ad Hoc Study Group on Criteria for Insensitive Explosives, Hazard Classification Division 1.5. The members of the Ad Hoc Group and their affiliations were:

Mr. F. West	Air Force	Chairman
Dr. L. Elkins	Air Force	Recorder
Mr. L. Avrami	Army	Member
Mr. E. Demberg	Army	Member
Mr. M. Swisdak	Navy	Member
Dr. C. Dickinson	Navy	Member
Mr. E. James	DOE	Member
Mr. M. Urizar	DOE	Member

After much discussion and deliberation, the Group reached a consensus on a test protocol for Division 1.5 substances and recommended them back to the DDESB on 24 April 1980.

The Secretariat at the DDESB indicated that they supported the test procedures for classifying insensitive high explosives substances as Hazard Division 1.5. They further recommended that for hazard classification testing of articles (note: emphasis is theirs) containing Hazard Division 1.5 substances, the requirements of STANAG 4123[4] and TB 700-2[5] should be followed. At the 279th Meeting of the DDESB, the report of the Ad Hoc Study Group was accepted with minor changes. These changes included a redefinition of Hazard Division 1.5.

> This division comprises Class/Division 1.1 explosives substances which, although mass detonating, are so insensitive that there is negligible probability of initiation or transition from burning to detonation in transport or storage.

The DDESB, however, still desired a well-defined test protocol which could be used for articles--not just substances.

In November 1980, the WPE requested additional comment and suggestions from various DOD and DOE groups concerning Class/Division 1.5 substances and munitions. In January 1981, comments were received from the Los Alamos Scientific Laboratory. Included among these was the following concerning testing of 1.5 articles:

> Attack of munitions, and perhaps even bulk HE, by small arms or fragments would seem to be a real concern. I believe an IHE item should not detonate, or even deflagrate with enough energy to detonate adjacent items, in a realistic multiple-hit bullet or fragment test. A multiple-hit test is a severe test, but automatic weapons and fragmenting munitions are a realistic threat. The first hit in an HE

charge causes damage and reduces charge density, effectively increasing HE sensitivity. The second hit is then far more likely to cause detonation.

On 23 January 1981 a DDESB memorandum for the three Service Board Members summarized the status of Hazard Classification for Insensitive Explosives. The following is quoted from that memorandum:

> . . . The 279th and 281st meetings of the Board . . . addressed hazard classification criteria for insensitive explosives. At the 279th meeting, the Board accepted the JTCG Ad Hoc Study Group report ... with certain changes and, in addition, established an interim hazard division 1.5 quantity-distance standard. At the 281st meeting, the Board addressed validation tests information furnished by the Ad Hoc Study Group and the Department of Energy on certain TATB formulations and comparative explosives. Included were results of tests which were not addressed . . . (e.g., multiple bullet impact test). It was stated that the multiple bullet impact test can give different, sometimes more violent, results than the single bullet impact test. The question was raised, but not resolved, as to its applicability in the test scheme for evaluating Division 1.5 explosives.

On 16 March 1981, the Ad Hoc Study Group was disestablished. The WPE then convened a special meeting for the purpose of reviewing and modifying as necessary the WPE recommendations to the DDESB and to prepare a final WPE position on this matter. The following is a list of participants at that meeting:

R. Sawyer	DDESB
W. Queen	DDESB
L. Elkins	Air Force
R. McGuire	DOE
M. Urizar	DOE
L. Avrami	Army
R. Beauregard	Navy
A. Amster	Navy
L. Roslund	Navy
C. Dickinson	Navy
M. Swisdak	Navy
H. Adolph	Navy
C. Dahn	Private Consultant

As a consequence of this meeting, the WPE forwarded to the DDESB a set of comments on modifications to its proposed test scheme. One of the comments is of particular importance and is quoted below:

> . . . UN hazard classification division 1.5 was devised for commercial blasting agents which are insensitive because of large critical diameters. A separate classification 1.X (or 1. some other designation) is recommended for military explosives which have relatively small critical diameters but still are insensitive. These two types of insensitive explosives respond differently to hazard stimuli and should not be covered in one category. . . . The division 1.X classification would apply and be restricted to materials passing an appropriate test scheme

and criteria, and having the same physical and chemical state properties as when tested.[6]

During testing of the warhead for the Ground Launched Cruise Missile (GLCM), the Air Force recommended the following tests for Class 1.5 articles:

Impact Test (Sled Track or Pull Down)
Bonfire
Bullet Impact

In addition to these tests, they had run the following tests:

Forty-Foot Drop
Propagation Test
Shaped Charge
Thermal Stability Test

On 19 January 1982, during the 283rd meeting of the DDESB, Hazard Class/Division 1.5 substance and article testing was again discussed. During discussions at this meeting, the bullet impact test was discussed for articles. Mr. Queen (of the DDESB Secretariat) indicates, "We would like to call your attention here to the bullet impact test and how we have stipulated that it be performed. And that we would only use 50 caliber bullets. . . ." Later in the same discussion Mr. Queen states, ". . . Now again, let me emphasize that we're talking here about not the substance, but rather ammunition items that contain the substance. . . . I would call your attention to the last one where we are indicating our concern about possible effects of powdering or whatever in the event of multiple bullet impact. We expect three round burst to be fired into this item for a minimum of three orientations."[7]

On 28 January 1982, at the 284th meeting of the DDESB, modifications to the DOD Explosives Safety Standards were approved. Included at this meeting was a discussion of terminology. Quoting from the minutes of the meeting ". . . 1.5 has its origin in transportation circles (the UN requirements for transportation), that it applies only to substances (namely, blasting agents) and that it really adds to confusion when you start talking about articles (ammunition) in the same manner. We feel that the term insensitive high explosive, as we proposed, avoids this and achieves the objective that we were trying to achieve. This does require changing the interim criteria but only in an incidental way; i.e., removing references to 1.5. . . ."[8] This position, and a discussion of the changes to the DOD standard are discussed in a DDESB letter.[9] This protocol for insensitive high explosive (IHE) materials is the one currently appearing in the DOD 6055.9-STD.[10] The protocol, shown as Appendix A in this document, consists of the following:

SCREENING TESTS

Impact Test
Friction Test
Differential Thermal Analysis (DTA)
Small-Scale Burn
Spark Tests

QUALIFICATION TESTS FOR IHE

Critical Diameter
Cap Test
Card Gap Test
Slow Cookoff
External Fire
Susan Test
Bullet Impact

QUALIFICATION TESTS FOR IHE AMMUNITION

Sled Test
Bonfire
Propagation
Slow Cookoff
Multiple Bullet

The test procedures for each test were referred to existing DOD documents which described the tests in more detail. The pertinent sections of the DOD protocol are reproduced in Appendix A.

DOD 6055.9-STD is a United States document with applicability limited to DOD agencies and their contractors. In order to achieve a wider distribution and applicability, the DDESB, as technical consultant to the DOT, continued to urge its adoption by the UN with the protocol incorporated into the document "Recommendations on the TRANSPORT OF DANGEROUS GOODS Tests and Criteria."

In 1983, the DDESB petitioned the DOT for the establishment of a regulation for the transport of IHE substances and IHE ammunition articles by or for a component of the DOD. The DDESB further proposed that the test protocol incorporated on DOD 6055.9-STD be included in Title 49, Part 149 of the Code of Federal Regulations (CFR).

In 1985, the United States (US) agreed to make a formal proposal to the UN Group of Experts on Explosives; this proposal concerned the inclusion of articles in Division 1.5. In April 1986, a draft of this proposal was transmitted to the US representative at the DOT. It was formally proposed at the 26th session of the Group of Experts on Explosives held in August 1986. The French made detailed comments and recommended several additions and changes. The test series, as modified by the French, was found to be generally acceptable by the US representative. The revised test protocol was presented and discussed at the 27th session of the Group of Experts on Explosives held 17 to 21 August 1987. As a result of the discussions at this meeting, the DDESB, in late 1987, requested that the Naval Surface Warfare Center (NSWC) review the existing protocol for Hazard Class/Division 1.5 and IHE materials. This review was to include, but was not limited to:

1. The coordination and the obtaining of recommendations of changes to the procedures with/from the appropriate Service hazard classification test experts

2. Conversion of US test weight and measure specifications into the international system of units (SI)

3. Conversion of US test materials/standard specifications to international terminology.

The tests included in the procedures at that time included:

1. Critical Diameter Test
2. Cap Test
3. Gap Test
4. Susan Test
5. Friability Test
6. Bullet Impact Test
7. External Fire Test
8. Slow Cookoff Test
9. Stack Test

Items 1 through 8 were to be performed on the substance; items 6 through 9 were to be performed on the article containing that substance tested in 1 through 8. At this time, there were two Gap test series in the protocol. The first was proposed by the US and the second by the French. The US tests consisted of the standard Large Scale Gap Test (LSGT) and the Expanded Large Scale Gap Test (ELSGT)[11] depending upon the critical diameter of the substance. The French Gap test also consisted of two tests--the test described in Section 2a (iv) of Reference 1 and the US ELSGT. The choice of which test was again dependent upon the critical diameter of the substance. The friability test was a French test which could be substituted for the US Bullet Impact and Susan Tests.

Within the US, the representative to the UN Committee of Experts on the Transportation of Hazardous Materials is the DOT. Any test procedures that are to be submitted to the UN must be approved and submitted by representatives of this organization. In early 1988, discussions were held between representatives of the DOT, the DDESB, and NSWC concerning the 1.5 test procedures. As a result of these and other discussions, certain tests were simplified and one, the critical diameter test, was eliminated.

Further discussions with the French simplified the Gap Test procedures. With the elimination of the Critical Diameter Test, it was decided that only one Gap Test Procedure would be required--the ELSGT. Further discussions set the pass/fail criterion for this test at 276 US cards (2.76 inches) or 70 mm of polymethyl methacrylate (PMMA). NSWC was also tasked to develop a "calibration curve" for this new Gap Test. The work has been completed and is reported in detail in References 12 and 13. Appendix B contains a summary of the required calibration information.

At a meeting of the UN Committee of Experts during 1988, it was decided that these new materials and articles really should be clearly distinguished from commercial blasting agents, which are also classified as 1.5 materials. To accomplish this, a new class/division was established: Class/Division 1.6 for articles which contain "Extremely Insensitive Detonating Substances (EIDS)." At the same meeting, the US/French test protocol was accepted and will be included in the next revision of Reference 1.

CHAPTER 2

HAZARD CLASS/DIVISION 1.6 TEST PROTOCOL

The following is quoted from the Introduction to Test Series 7 for Class/Division 1.6 materials. The figure and paragraph numbers refer to sections found in Reference 1.

INTRODUCTION

45.1 The question, "Is the result an extremely insensitive explosive article?" (Fig. 1.3, box 40) is answered by Series 7 Tests and any candidate for Division 1.6 must pass all the tests listed. Tests 7(a) to 7(k) shown in paragraphs 45.2 to 45.11 permit the classification of articles of Division 1.6 comprising Extremely Insensitive Detonating Substances (EIDS).

45.2 Type 7(a) test: Shock test to determine the sensitivity to detonation by a standard detonator.

e.g., Test 7(a) EIDS Cap Test.

45.3 Type 7(b) test: Shock test with a defined booster and confinement to determine the sensitivity to shock.

e.g., Test 7(b) EIDS Gap Test.

45.4 Type 7(c) test: Test to determine the sensitivity of the explosive substance to deteriorate under the effect of an impact.

e.g., Test 7(c)(i) Susan Impact Test
Test 7(c)(ii) Friability Test

45.5 Type 7(d) test: Test to determine the degree of reaction of the explosive substance to impact or penetration resulting from a given energy source.

e.g., Test 7(d)(i) EIDS Bullet Impact Test
Test 7(d)(ii) Friability Test

45.6 Type 7(e) test: Test to determine the reaction of the explosive substance to an external fire when the material is confined.

e.g., Test 7(e) EIDS External Fire Test.

45.7 Type 7(f) test: Test to determine the reaction of the explosive substance in an environment in which the temperature is gradually increased to 365°C.

e.g., Test 7(f) EIDS Slow Cookoff Test.

45.8 Type 7(g) test: Test to determine the reaction to an external fire of an article which is in the condition as presented for transport.

e.g., Test 7(g) Division 1.6 Article External Fire Test.

45.9 Type 7(h) test: Test to determine the reaction of an article in an environment in which the temperature is gradually increased to 365°C.

e.g., Test 7(h) Division 1.6 Article Slow Cookoff Test.

45.10 Type 7(j) test: Test to determine the reaction of an article to impact or penetration resulting from a given energy source.

e.g., Test 7(j) Division 1.6 Article Bullet Impact Test.

45.11 Type 7(k) test: Test to determine if an article will detonate a similar item adjacent to it which is in the condition as presented for transport.

e.g., Test 7(k) Division 1.6 Article Propagation Test.

45.12 A substance intended for use as the explosive load in an article of Division 1.6, should be tested in accordance with Test Series 3 and 7. Test Series 7 should be conducted in the form (i.e., composition, granulation, density, etc.) in which it is to be used in the article.

45.13 An article being considered for inclusion in Division 1.6 should not undergo Test Series 7 testing until after its explosive load has undergone Tests 7(a) through 7(f) to determine whether it is an EIDS.

The explosive load is not an EIDS if a "+" is obtained in any one of Tests 7(a) through 7(f).

\+ means that the substance is too sensitive
\- means that the substance is not too sensitive.

To determine if the article with an EIDS load is a Division 1.6 article, Tests 7(g) through 7(k) are performed. These tests are applied to articles in the condition and form in which they are offered for transport, except that non-explosive components may be omitted or simulated if the competent authority is satisfied that this does not invalidate the results of the tests.

The question in Box 40 is answered "NO" if a "+" is obtained in any one of Tests 7(a) through 7(k).

The entire test protocol including Figure 1.3 (which is referred to above) is presented in Appendix C.

CHAPTER 3

SUBSTANCE TESTING

As part of the agreement between the US and the other members of the Committee of Experts on the Transport of Hazardous Materials, the US agreed to take at least two materials through the entire EIDS test procedure. The two materials chosen were Composition B (a melt cast material consisting of 60 percent RDX and 40 percent TNT with 1 percent wax added) and PBX-9502 (a pressed material consisting of 95 percent TATB and 5 percent KEL-F). The Composition B was chosen as representative of many of the current melt-cast systems and was expected to fail almost every test. The PBX-9502 was chosen to represent the new insensitive, plastic bonded explosives, and was expected to pass every test. In addition, the French would submit three of their materials to the protocol. The French materials were:

1. Octorane 86A (86 percent HMX, 14 percent inert binder)
2. B3003 (80 percent HMX, 20 percent energetic binder)
3. B3103 (51 percent HMX, 30 percent energetic binder, 19 percent aluminum).

The French would submit their materials to the friability test, and the US would submit theirs to the Bullet Impact and the Susan Tests. In addition, samples were exchanged between the US and France. The Friability Test would be performed on the US materials and the Susan Test performed on the French materials. The details of the testing and the results obtained are presented in Appendices D through I. The results are summarized in Table 3-1. The full test results for the French materials were not available at the time of publication of this report. The French results will, ultimately, be published in a French report.

Three other US materials (developed under contract to the US Air Force) have been tested to an older version of the test protocol. These three materials are:

1. AFX-920 (22 percent RDX, 33 percent HBNQ (high bulk nitroguanidine), 15 percent EDDN, 14 percent aluminum, and 15 percent binder)
2. AFX-930 (32 percent RDX, 37 percent HBNQ (high bulk nitroguanidine), 15 percent aluminum, 9 percent binder, and 7 percent plasticizer)
3. AFX-931 (32 percent RDX, 37 percent AP (Ammonium Perchlorate), 15 percent aluminum, 9 percent binder, and 7 percent plasticizer)

A careful examination of the testing protocol used for these materials reveals no substantial differences between it and the currently accepted protocol. For this reason, these materials have also been included in Table 3-1.

TABLE 3-1. HAZARD CLASS/DIVISION 1.6 TEST RESULTS–SUMMARY

SUBSTANCE	TEST						
	EIDS CAP TEST	EIDS GAP TEST	SUSAN TEST	FRIABILITY TEST	EIDS BULLET IMPACT TEST	EIDS EXTERNAL FIRE TEST	EIDS SLOW COOKOFF TEST
COMPOSITION B	+	+	+	+	+	+	+
PBX-9502	–	–	–	–	–	–	–
OCTORANE 86A	1	1	–	–	1	1	–
B3003	1	1	+	+	1	1	+
B3103	1	1	+	–	1	1	–
AFX-920	–	–	–	2	–	–	–
AFX-930	–	–	–	2	–	–	–
AFX-931	–	–	–	2	–	–	–

+ indicates that the substance failed the test
– indicates that the substance passed the test
1 indicates data not available
2 indicates the test not required (alternate test)

REFERENCES

1. Recommendations on the TRANSPORT OF DANGEROUS GOODS; Tests and Criteria, United Nations Publication, ST/SG/AC.10/11, NY, 1986.

2. DDESB ltr of 6 Nov 1979, Subj: "Explosives Hazard Classification for Triaminotrinitrobenzene (TATB) Formulations."

3. DDESB ltr of 5 Feb 1980, Subj: "Explosives Hazard Classification for Triaminotrinitrobenzene (TATB) Formulations."

4. NATO Standard National Agreement STANAG 4123 (Edition 2), "Methods to Determine and Classify the Hazards of Ammunition," Oct 1978.

5. Defense Logistics Agency Regulation (DLAR) 8220.1 (TB 700-2, NAVSEAINST 8020.8, TO 11A-1-47), "Department of Defense Explosive Hazard Classification Procedures," Sep 1982.

6. Joint Technical Coordinating Group For Munitions Development: Working Party For Explosives ltr, Serial 64E/HGA 114 of 4 Sep 1981, Subj: "Hazard Classification For Insensitive Munitions and Explosives."

7. Minutes of the 283rd DDESB Meeting.

8. Minutes of 284th DDESB Meeting.

9. DDESB ltr of 24 Feb 1982, Subj: "Report of the 284th Meeting of the Department of Defense Explosives Safety Board."

10. Department of Defense Ammunition and Explosives Safety Standards, DOD 6055.9-STD, First Amendment (Change 2), 28 Oct 1988.

11. Liddiard, T. P. and Price, D., The Expanded Large Scale Gap Test, NSWC TR 86-32, Mar 1987.

12. Tasker, D. and Baker, R., "A New Unbiased Method For Analyzing Streak Data, The Calibration of the NSWC Expanded Large Scale Gap Test (ELSGT)," paper presented at the American Physical Society Meeting, 1989.

13. Tasker, D. and Baker, R., An Explosive Calibration of the NSWC Expanded Large Scale Gap Test (ELSGT), NSWC TR 89-204, in preparation.

APPENDIX A

EXCERPTS FROM DOD 6055.9-STD

(Change 2 10/28/88)

H. TEST PROCEDURES DOCUMENTS

The following documents set forth procedures to be used in the IHE and IHE ammunition testing required by sections I. through K., below:

1. TB = DoD Hazard Classification Procedures (TB 700-2) (reference (b)).
2. JSSPM = Joint Services Safety and Performance Manual (reference (c)).
3. DoD-STD-2105(NAVY) = Hazard Assessment Tests for Navy Non-Nuclear Ordnance (reference (d)).
4. JHEM = Joint Munitions Effectiveness Manual, Air-to-Surface Joint Service Test Procedures for Bombs and Bomblets (NAVAIR 00-130-ASR-2-1) (reference (e)).

I. SCREENING TESTS FOR IHE

Substances that are candidates for the designation as IHE shall be subjected to the screening tests specified below. Failure to achieve required results in a single test is not disqualifying provided all others are achieved. However, it does signal the need for careful evaluation.

Test Procedures

Test	Document	Required Results
Impact Test	TB 700-2	Sensitivity less than Explosive D
Friction Test	JSSPM	No reaction
Differential Thermal Analysis (DTA)	JSSPM	No exotherm at 250° C
Small Scale Burn	TB 700-2	No detonation or violent reaction
Spark Tests	JSSPM	No reaction at 0.25 joule

J. QUALIFICATION TESTS FOR IHE

Substances judged on the basis of screening test results stated in section I., above, to be legitimate candidates for designation as IHE shall be subjected to tests specified in Table 3-1. Required results as stated shall be achieved for qualification as IHE.

K. QUALIFICATION TESTS FOR THE IHE AMMUNITION

To qualify as IHE ammunition, ammunition containing IHEs must be subjected to tests specified in Table 3-2 and achieve required results as stated. In addition, it must be demonstrated by actual test that intentional detonation of one item will be incapable of propagating detonation to another like item.

Table 3-1 — Qualification Tests for IHE

Test	Test Procedures Document	No. of Trials	Sample[1]	Required Results
Critical	JSSPM		$L_s/D_s = 4$ D_s (inches) increased in 1 inch increments (1,2,3 etc.)	Critical diameter[2] = Minimum diameter sample for steady state detonation
Cap test	TB	5	$L_s/D_s = 4$; $D_s = 3 \times D_c$	No reaction
Card gap test	TB		D_s = (see note 3 below)	No reaction at (see note 4)
Slow cook-off	DoD-STD-2101 (NAVY)	3	$L_s/D_s = 4$; $D_s = 3 \times D_c$ (confined in Sched. 40 pipe, capped at 150 ft.-lb. torque)	* No reaction more severe than burning (See note 5) *
External Fire	TB	1	$L_s/D_s = 4$; $D_s = 3 \times D_c$ (confined in Sched. 40 pipe, capped at 150 ft.-lb torque)	No detonation or violent reaction with fragment throw
Susan test	JSSPM	3		Less than 10% TNT equivalent output
Bullet impact	JSSPM	6	$L_s/D_s = 4$; $D_s = 3 \times D_c$ (confined in Sched. 40 pipe, capped at 150 ft.-lb torque) 3 trials in axial orientation and 3 trials in longitudinal orientation	No reaction when impacted by 0.50 Caliber projectile

[1] L_s = Sample length; D_s = Sample diameter

[2] D_c = Critical diameter

[3] The test sample shall have a length to diameter ratio of 3.83 where the sample diameter is either 1.44 inches or 2.94 inches depending, respectively, upon whether the test material has a confined d_c <.72 in. or 0.72 in. $< d_c <$1.47 in.

[4] Where a substance has an unconfined or confined d_c<.72., it shall be tested at a gap of .69 inches. Should the substance detonate during any trial, it may not be classed as an IHE. Where a substance has a confined critical diameter 0.72 in. $<(d_c) <$1.44 in., it shall be tested at a gap that correlates to the .69 in. gap for the smaller diameter test. Should the substance detonate during any trial, it may not be classed as an IHE.

* [5] Burning is defined as the energetic material ignites and burns. The case may melt or weaken sufficiently to allow mild release of the combustion gases. Debris stays in the area of the test. Case closures may be dislodged by the internal pressure and thrown up to about 50 feet. *

*First Amendment (Ch 1, 8/19/86)

Table 3-2 — Qualification Tests for IHE Ammunition

Test	Test Procedures Document	Sample	Stimulus	Required Result
Sled test	JMEM	All-up round/w.o. overpack	Impact hard surface at 450 meters per second velocity	No detonation
Bonfire	TB	Ammo in storage & shipping configuration	Open fire	No detonation
Propagation	DoD-STD-2105(NAVY)	Ammo in storage & shipping configuration	Detonated all-up round in storage or shipping configuration	No propagation of detonation
Slow cook-off	DoD-STD-2105(NAVY)	Ammo in storage & shipping configuration	Heat to reaction temperature	No detonation or violent reaction with fragment throw
Multiple bullet	DoD-STD-2105(NAVY)	All-up round in 3 different orientations	.50 cal AP ammo fired at service velocity in 3-round bursts	No detonation

Table 3-4 - IHE and IHE Ammunition Hazard Classification/Compatibility Groups

IHE bulk	1.5D
IHE Loaded projectiles and/or warheads w/o fuzes or with IHE Fuzes[1,2]	1.5D
IHE Fuzes[1]	1.4D
IHE loaded projectiles and/or warheads w/ 1.3 propelling charges and without Fuzes or with IHE Fuzes[1,2]	1.3C/1.2C[3]
IHE loaded projectiles and/or warheads with non-IHE[2] Fuzes and without 1.3 propelling charges	1.2D[3,4]
IHE loaded projectiles and/or warheads with non-IHE[2,4] Fuzes and with 1.3 propelling charges	1.2E[3,4]

[1]"IHE Fuzed" means that the fuze has an IHE booster with an out-of-line non-IHE explosive and two or more independent safety features. The fuze must be certified as invulnerable to accidental detonation of the warhead.

[2]Fuzed configuration must be tested for propagation.

[3]Unit risk may be justified on a case-by-case basis.

[4]Fuze must have two or more independent safety features and independently classified Group D.

NOTE: When stored with compatible items of other Q-D classes, the most restrictive Q-D class will apply.

#First Amendment (Ch 2, 10/28/88)

H. CLASS/DIVISION 1.5 Q-D DETERMINATIONS

1. Scope. This section establishes Q-D standards for ammunition and explosives that have been hazard classified Class/Division 1.5 as a result of hazard classification testing under requirements in Chapter 3, sections I through K.

2. Quantity of Explosives. The weight of explosives shall include a suitable addition for propellant or pyrotechnic components if they contribute to the reaction. A maximum of 500,000 lbs shall be permitted at any one location.

3. Q-D Application

a. Quantity-distance separations for Class/Division 1.5 ammunition and explosives shall be based on current Class/Division 1.2, 1.3, and 1.4 tables depending on the storage location and configuration. This information is detailed in Table 9-28 and the following paragraphs.

Table 9-28 - Q-D Criteria for Class/Division 1.5 Components and Assemblies with other Class/Division Components

Location	Explosive Configuration		Ammunition Configuration	
	Bulk	Non-IHE Fuzed[2] with or without 1.3 propelling charge	Unfuzed or with IHE Fuze[2],[4] 1.3 propelling charge	Without 1.3 propelling charge
Igloo Storage	Div 1.3	Div 1.2[3]	Div 1.3	Div 1.3/1.4[5]
All Others	Div 1.3	Div 1.2[3]	Div 1.3[1]	Div 1.3[1]

[1]Unit risk minimum fragment distance applies, unless excepted on a case-by-case basis by the DDESB.

[2]Fuzed configuration must be tested for propagation.

[3]Unit risk may be justified on a case-by-case basis.

[4]"IHE Fuzed" means that the fuze has an IHE booster with an out-of-line non-IHE explosive and two or more independent safety features.

[5]Class/Division 1.4 applies for items packed in non-flammable pallets or packing, stored in earth-covered steel or concrete arch magazines when acceptable to the DoD Component and the DDESB on a site-specific basis.

b. Inhabited building distances for bulk Class/Division 1.5 explosives shall be based on Table 9-10, column 2. Inhabited building distances for Class/Division 1.5 ammunition shall be the greater of Tables 9-6 through 9-10, column 2 distances as applicable, or the unit risk hazardous fragment distance, as specified by note 1 in Table 9-28.

c. Public traffic route distances for bulk Class/Division 1.5 explosive shall be based on Table 9-10, column 3. Inhabited building distances for Class/Division 1.5 ammunition shall be the greater of Table 9-6, column 2 through 9-10 distances, as applicable, or the unit risk hazardous fragment distance as specified by note 1 in Table 9-28.

d. Intraline distances for Class/Division 1.5 explosives shall be based on Table 9-10, column 4. Intraline distances for Class/Division 1.5 ammunition shall be the greater of Tables 9-5 through 9-10, column 4 distances, as applicable or 50 percent of the unit risk hazardous fragment distances, as specified by note 1 in Table 9-28.

e. Aboveground magazine distances for Class/Division 1.5 explosives shall be based on Table 9-10, column 4. Aboveground magazine distances for Class/Division 1.5 ammunition shall be based on Tables 9-6 through 9-9, column 5, as applicable or Table 9-10, column 4 with a 200 ft minimum when there is no intervening barricade.

f. Any special storage configuration and siting approved for Class/Division 1.1 ammunition or explosives may be used for the storage of like quantities of Class/Division 1.5 ammunition or explosives, respectively.

4. Colocation/Separation Requirements

a. Class/Division 1.5 ammunition and explosives that are located with or located at less than magazine distance from Class/Division 1.1 or 1.2 ammunition and explosives shall be treated as Class/Division 1.1 for Q-D purposes.

b. Class/Division 1.5 ammunition and explosives located with Class/Division 1.3 or 1.4 ammunition and explosives shall be treated as Class/Division 1.3 for Q/D purposes with a 500,000 lb maximum limit.

I. MILITARY WORKING DOG EXPLOSIVES SEARCH TRAINING

1. General. Realistic and effective training of military working dogs (MWD) to detect explosives that have been hidden in various public places requires that simulated searches are conducted in areas that are regularly inhabited by people. It is essential that the training is conducted so that all persons unrelated to training of the dogs are not exposed to the hazards associated with an accidental explosion of a training sample.

2. Operation On Explosives Used for Training. Because of the dangers inherent in explosives operations including handling explosives, cutting or dividing explosive training aids, removing explosives from the shipping and storage container, and repackaging explosives into other containers, these operations shall be conducted by qualified personnel only in facilities that meet the Q-D and other requirements of this Standard.

3. Storing Explosives Training Aids. Explosives must be stored in facilities that meet the Q-D and other requirements of this Standard.

4. Explosives Detection Proficiency Training Safety Procedures. Persons unrelated to the training of the dogs must not be exposed to the hazards associated with an accidental explosion of the training sample. Therefore, at the training site:

APPENDIX B

EXPANDED LARGE SCALE GAP TEST (ELSGT) CALIBRATION

Prepared by

Douglas G. Tasker

(NOTE: Pressures in GPa)

GAP THICKNESS (mm)	INCREMENT (mm)			
	"+0"	"+0.25"	"+0.50"	"+0.75"
9.00	10.96	10.89	10.81	10.74
10.00	10.67	10.59	10.52	10.43
11.00	10.35	10.28	10.21	10.14
12.00	10.06	9.99	9.92	9.85
13.00	9.79	9.73	9.66	9.61
14.00	9.55	9.49	9.43	9.37
15.00	9.31	9.26	9.20	9.15
16.00	9.10	9.04	8.99	8.93
17.00	8.88	8.82	8.77	8.73
18.00	8.67	8.63	8.58	8.53
19.00	8.48	8.44	8.39	8.35
20.00	8.31	8.27	8.23	8.18
21.00	8.14	8.11	8.07	8.03
22.00	8.00	7.96	7.93	7.89
23.00	7.88	7.83	7.79	7.76
24.00	7.72	7.69	7.66	7.62
25.00	7.58	7.55	7.51	7.48
26.00	7.44	7.40	7.37	7.33
27.00	7.30	7.26	7.23	7.19
28.00	7.16	7.13	7.09	7.06
29.00	7.03	7.00	6.97	6.94
30.00	6.91	6.88	6.85	6.82
31.00	6.79	6.77	6.74	6.71
32.00	6.68	6.65	6.62	6.59
33.00	6.57	6.54	6.51	6.48
34.00	6.45	6.42	6.40	6.37
35.00	6.34	6.32	6.29	6.27
36.00	6.25	6.23	6.20	6.18
37.00	6.16	6.14	6.12	6.10
38.00	6.08	6.07	6.05	6.03
39.00	6.01	6.00	5.97	5.96
40.00	5.94	5.92	5.90	5.88
41.00	5.86	5.83	5.81	5.79
42.00	5.77	5.75	5.73	5.71
43.00	5.69	5.67	5.66	5.64
44.00	5.62	5.61	5.59	5.57
45.00	5.56	5.54	5.53	5.51
46.00	5.49	5.47	5.45	5.44
47.00	5.42	5.39	5.38	5.35
48.00	5.33	5.31	5.29	5.27
49.00	5.25	5.23	5.22	5.20
50.00	5.18	5.17	5.15	5.14
51.00	5.13	5.11	5.10	5.09
52.00	5.08	5.07	5.06	5.04
53.00	5.03	5.02	5.00	4.99
54.00	4.98	4.96	4.94	4.93
55.00	4.91	4.89	4.87	4.85
56.00	4.83	4.81	4.79	4.78
57.00	4.76	4.74	4.72	4.70
58.00	4.68	4.66	4.64	4.62
59.00	4.60	4.58	4.56	4.53
60.00	4.51	4.49	4.46	4.44

(NOTE: Pressures in GPa)

GAP THICKNESS (mm)	INCREMENT (mm)			
	"+0"	"+0.25"	"+0.50"	"+0.75"
61.00	4.41	4.39	4.37	4.34
62.00	4.31	4.28	4.26	4.24
63.00	4.22	4.19	4.17	4.15
64.00	4.13	4.10	4.08	4.05
65.00	4.02	4.00	3.97	3.94
66.00	3.91	3.88	3.86	3.83
67.00	3.80	3.78	3.75	3.72
68.00	3.70	3.68	3.66	3.63
69.00	3.61	3.59	3.57	3.55
70.00	3.53	3.51	3.48	3.46
71.00	3.43	3.41	3.39	3.37
72.00	3.34	3.31	3.29	3.26
73.00	3.23	3.20	3.18	3.15
74.00	3.13	3.11	3.09	3.07
75.00	3.05	3.03	3.01	3.00
76.00	2.98	2.96	2.95	2.93
77.00	2.92	2.90	2.89	2.87
78.00	2.85	2.83	2.80	2.78
79.00	2.76	2.74	2.71	2.69
80.00	2.66	2.64	2.61	2.59
81.00	2.57	2.55	2.53	2.51
82.00	2.50	2.48	2.47	2.45
83.00	2.44	2.43	2.42	2.41
84.00	2.40	2.39	2.38	2.37
85.00	2.36	2.35	2.34	2.33
86.00	2.31	2.30	2.29	2.27
87.00	2.26	2.25	2.23	2.22
88.00	2.20	2.19	2.18	2.16
89.00	2.15	2.14	2.13	2.11
90.00	2.10	2.09	2.08	2.07
91.00	2.06	2.05	2.04	2.03
92.00	2.02	2.02	2.01	2.00
93.00	1.99	1.99	1.98	1.97
94.00	1.96	1.96	1.95	1.94
95.00	1.94	1.93	1.93	1.92
96.00	1.91	1.91	1.90	1.89
97.00	1.89	1.87	1.86	1.84
98.00	1.82	1.81	1.79	1.78
99.00	1.73	1.69	1.66	1.62
100.00	1.57	1.52	1.46	

APPENDIX C

CLASS/DIVISION 1.6
TEST PROTOCOL

(as contained in the following United Nations documents)

ST/SG/AC.10/C.3/2	25 August 1989
ST/SG/AC.10/C.3/R.19	9 May 1989
ST/SG/AC.10/15/Add.1	17 January 1989
ST/SG/AC.10/R.258	13 October 1988
ST/SG/AC.10/R.199	5 September 1988
ST/SG/AC.10/C.1/20	25 August 1988
ST/SG/AC.10/C.1/R.236	27 June 1988
ST/SG/AC.10/C.1/18	30 September 1987
ST/SG/AC.10/C.1/R.205	26 June 1987
ST/SG/AC.10/C.1/16	25 August 1986
ST/SG/AC.10/C.1/R.195	29 May 1986

Note: The actual composition of Composition B is 60 percent RDX and 40 percent TNT with 1 percent wax added. This correction will be made in future revisions of the protocol.

TEST SERIES 7 FOR CLASS/DIVISION 1.6 ARTICLES

(Articles Containing Extremely Insensitive Detonating Substances (EIDS))

TEST SERIES 7

INTRODUCTION

45.1 The question, "Is the result an extremely insensitive explosive article?" (Fig. 1.3, box 40) is answered by Series 7 Tests and any candidate for Division 1.6 must pass all the tests listed. Tests 7(a) to 7(k) shown in paragraphs 45.2 to 45.11 permit the classification of articles of Division 1.6 comprising Extremely Insensitive Detonating Substances (EIDS).

45.2 Type 7(a) test: Shock test to determine the sensitivity to detonation by a standard detonator.

e.g., Test 7(a) EIDS Cap Test.

45.3 Type 7(b) test: Shock test with a defined booster and confinement to determine the sensitivity to shock.

e.g., Test 7(b) EIDS Gap Test.

45.4 Type 7(c) test: Test to determine the sensitivity of the explosive substance to deteriorate under the effect of an impact.

e.g., Test 7(c)(i) Susan Impact Test
Test 7(c)(ii) Friability Test

45.5 Type 7(d) test: Test to determine the degree of reaction of the explosive substance to impact or penetration resulting from a given energy source.

e.g., Test 7(d)(i) EIDS Bullet Impact Test
Test 7(d)(ii) Friability Test

45.6 Type 7(e) test: Test to determine the reaction of the explosive substance to an external fire when the material is confined.

e.g., Test 7(e) EIDS External Fire Test.

45.7 Type 7(f) test: Test to determine the reaction of the explosive substance in an environment in which the temperature is gradually increased to 365°C.

e.g., Test 7(f) EIDS Slow Cookoff Test.

45.8 Type 7(g) test: Test to determine the reaction to an external fire of an article which is in the condition as presented for transport.

e.g., Test 7(g) Division 1.6 Article External Fire Test.

45.9 Type 7(h) test: Test to determine the reaction of an article in an environment in which the temperature is gradually increased to 365°C.

e.g., Test 7(h) Division 1.6 Article Slow Cookoff Test.

45.10 Type 7(j) test: Test to determine the reaction of an article to impact or penetration resulting from a given energy source.

e.g., Test 7(j) Division 1.6 Article Bullet Impact Test.

45.11 Type 7(k) test: Test to determine if an article will detonate a similar item adjacent to it which is in the condition as presented for transport.

e.g., Test 7(k) Division 1.6 Article Stack Test.

45.12 A substance intended for use as the explosive load in an article of Division 1.6, should be tested in accordance with Test Series 3 and 7. Test Series 7 should be conducted in the form (i.e., composition, granulation, density, etc.) in which it is to be used in the article.

45.13 An article being considered for inclusion in Division 1.6 should not undergo Test Series 7 testing until after its explosive load has undergone Tests 7(a) through 7(f) to determine whether it is an EIDS.

The explosive load is not an EIDS if a "+" is obtained in any one of Tests 7(a) through 7(f).

+ means that the substance is too sensitive
- means that the substance is not too sensitive.

To determine if the article with an EIDS load is a Division 1.6 article, Tests 7(g) through 7(k) are performed. These tests are applied to articles in the condition and form in which they are offered for transport, except that nonexplosive components may be omitted or simulated if the competent authority is satisfied that this does not invalidate the results of the tests.

The question in Box 40 is answered "NO" if a "+" is obtained in any one of Tests 7(a) through 7(k).

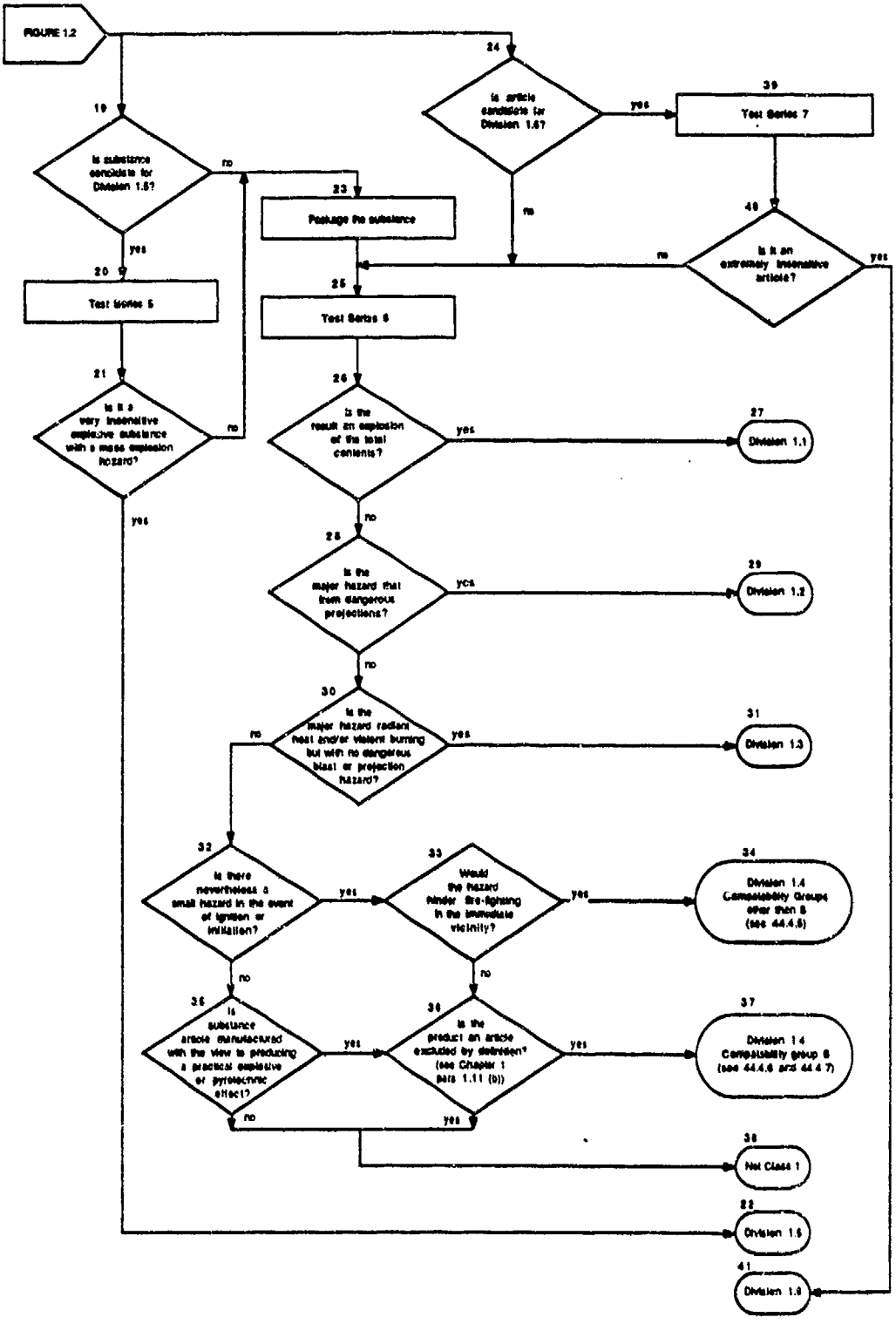


FIGURE 1.3. PROCEDURE FOR ASSIGNMENT OF HAZARD DIVISION

TEST 7(a)

EIDS CAP TEST

46.1 INTRODUCTION

This test is designed to determine the sensitivity of an EIDS candidate to the shock from a standard detonator or blasting cap. The test yields quantitative and unambiguous results.

46.2 APPARATUS AND MATERIALS

The experimental setup for this test is the same as for TEST 5(a) (see paragraph 36.2).

46.3 PROCEDURE

The experimental procedure is the same as for TEST 5(a) (see paragraph 36.3).

46.4 CRITERIA

An explosive substance which detonates is too sensitive to be classified as an EIDS and the result is noted as a "+."

46.5 EXAMPLES OF RESULTS

TEST SUBSTANCE	RESULT	DATA REFERENCE
COMPOSITION B	+	USA SOURCES
PBX-9502	-	

COMPOSITION B: melt cast material consisting of 60 percent RDX and 40 percent TNT

PBX-9502: pressed material consisting of 95 percent TATB and 5 percent KEL-F

TEST 7(b)

EIDS GAP TEST

47.1 INTRODUCTION

This test is used to measure the sensitivity of an EIDS candidate to a specified shock level; i.e., specified donor charge and gap.

47.2 APPARATUS AND MATERIALS

The setup for this test consists of an explosive charge (donor), a barrier (gap), a container holding the test charge (acceptor), and a steel witness plate (target).

The following materials should be used in the performance of this test:

(a) United Nations Standard Detonator or equivalent.

(b) 95 mm diameter by 95 mm long pressed 50/50 pentolite or 95/5 RDX/WAX pellet with a density of 1600 kg/m^3 ± 50 kg/m^3.

(c) Tubing, steel, cold drawn seamless, 95 mm OD, 11 mm wall thickness ± 10 percent variations, by 280 mm long having the following mechanical properties:

tensile strength	=	420 MPa (±20 percent variation)
elongation (percent)	=	22 (±20 percent variation)
Brinell hardness	=	125 (±20 percent variation).

(d) Sample substances, machined to a diameter which is just under the inner diameter of the steel tubing. There should be a minimum air gap between the sample and tubing wall.

(e) Cast polymethyl methacrylate (PMMA) rod stock, 95 mm diameter by 70 mm long.

(f) Mild steel plate, 200 mm x 200 mm x 20 mm, having the following mechanical properties:

tensile strength	=	580 MPa (±20 percent variation)
elongation (percent)	=	21 (±20 percent variation)
Brinell hardness	=	160 (±20 percent variation).

(g) Cardboard tubing, 97 mm ID by 443 mm long.

(h) Wood block with hole drilled through center to hold detonator, 95 mm diameter by 25 mm long.

47.3 PROCEDURE

As shown in Figure 47.1, the detonator, donor, gap, and acceptor charge are coaxially aligned above the center of the witness plate. A 1.6 mm air gap is maintained between the free end of the acceptor charge and the witness plate with suitable spacers which do not overlap the acceptor charge. Care should be taken to assure good contact between the detonator and donor, donor and gap, and gap and acceptor charge.

To assist in collecting the remains of the witness plate, the whole assembly may be mounted over a container of water with at least 10 cm of air gap between the surface of the water and the bottom surface of the witness plate which should be supported along the edges only.

Alternative collection methods may be used but it is important to allow sufficient free space below the witness plate so as not to impede plate puncture. The test is repeated three times.

The test sample and booster are to be at a temperature of 25°C ± 5° at the time of the test.

47.4 CRITERIA AND METHOD OF ASSESSING RESULTS

A clean hole punched through the plate indicates that a detonation was initiated in the sample. A substance which detonates in any trial is not an EIDS and the result is noted as "+."

47.5 EXAMPLES OF RESULTS

TEST SUBSTANCE	RESULT	DATA REFERENCE
COMPOSITION B	+	USA SOURCES
PBX-9502	-	

COMPOSITION B: melt cast material consisting of 60 percent RDX and 40 percent TNT

PBX-9502: pressed material consisting of 95 percent TATB and 5 percent KEL-F

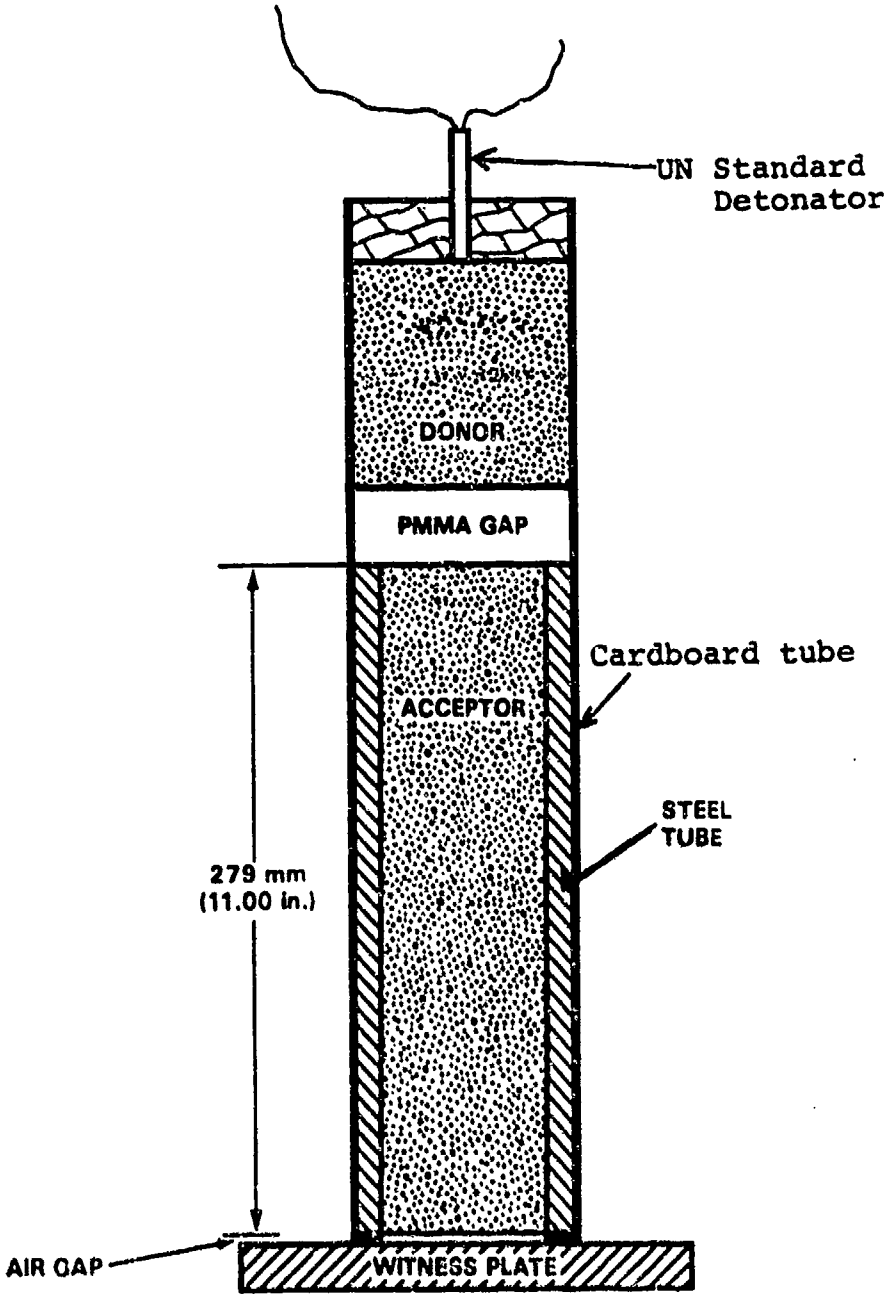


FIGURE 47.1. EIDS GAP TEST

TEST 7(c)(i)

SUSAN IMPACT TEST

48.1 INTRODUCTION

The Susan Impact Test is designed to assess the degree of explosive reaction under conditions of high velocity impact. The test is conducted by loading the explosives into standardized projectiles and firing the projectiles against a target at specified velocity.

48.2 APPARATUS AND MATERIALS

48.2.1 Explosive billets, 51 mm in diameter by 102 mm long, which are fabricated by normal techniques, are employed.

48.2.2 The Susan Test employs the test vehicle shown in Figure 48.1. The projectile has an assembled weight of 5.4 kg, and contains approximately 0.45 kg of explosive. Overall dimensions are 8.13 cm in diameter by 22 cm long.

48.2.3 The projectiles are fired from a 81.3 mm smoothbore gun. The gun muzzle is 4.6 meters from a 6.4 cm thick, smooth-surface, armor steel target plate. Projectile impact velocities are varied by adjusting the propellant charges in the gun.

48.2.4 A schematic drawing of the firing range showing the target-gun layout and the relative positions of the diagnostic equipment is shown in Figure 48.2. The flight path is about 1.2 meters above ground level.

48.2.5 The test site is equipped with calibrated blast gauges and recording equipment. The airblast recording system should have a system frequency response of at least 20 KHz. Measurements are made of impact velocities and air shock blast overpressure. Air blast is measured at a distance of 3.05 m from the impact point (gauges 1, 2, and 3 in Figure 48.2)

48.3 PROCEDURE

48.3.1 The propellant charge in the gun should be adjusted to produce a projectile velocity of 333 m/s. The projectile is fired and the impact velocity and airblast produced as a result of its reaction on impact are recorded. If a velocity of 333 m/s (+10%, -0%) is not obtained, the amount of propellant is adjusted and the test repeated.

48.3.2 Once an impact velocity of 333 m/s is obtained, the test is repeated until at least 10 accurate pressure-time records are obtained from at least five separate shots. On each of these accurate shots, the impact velocity must be 333 m/s (+10%, -0%).

48.4 CRITERIA AND METHOD OF ASSESSING RESULTS

The maximum airblast overpressure that is determined from each airblast record is recorded. The average of the maximum pressures obtained is recorded. A minimum of 10 records are necessary for a valid average. If the average pressure obtained by such a procedure is greater than or equal to 27 kPa (the blast overpressure that a like mass of cast TNT would contribute at a velocity of 333 m/s), then the substance is not an EIDS and the result is noted as "+."

48.5 EXAMPLES OF RESULTS

TEST SUBSTANCE	RESULT	DATA REFERENCE
COMPOSITION B	+	USA SOURCES
PBX-9502	-	

COMPOSITION B: melt cast material consisting of 60 percent RDX and 40 percent TNT

PBX-9502: pressed material consisting of 95 percent TATB and 5 percent KEL-F

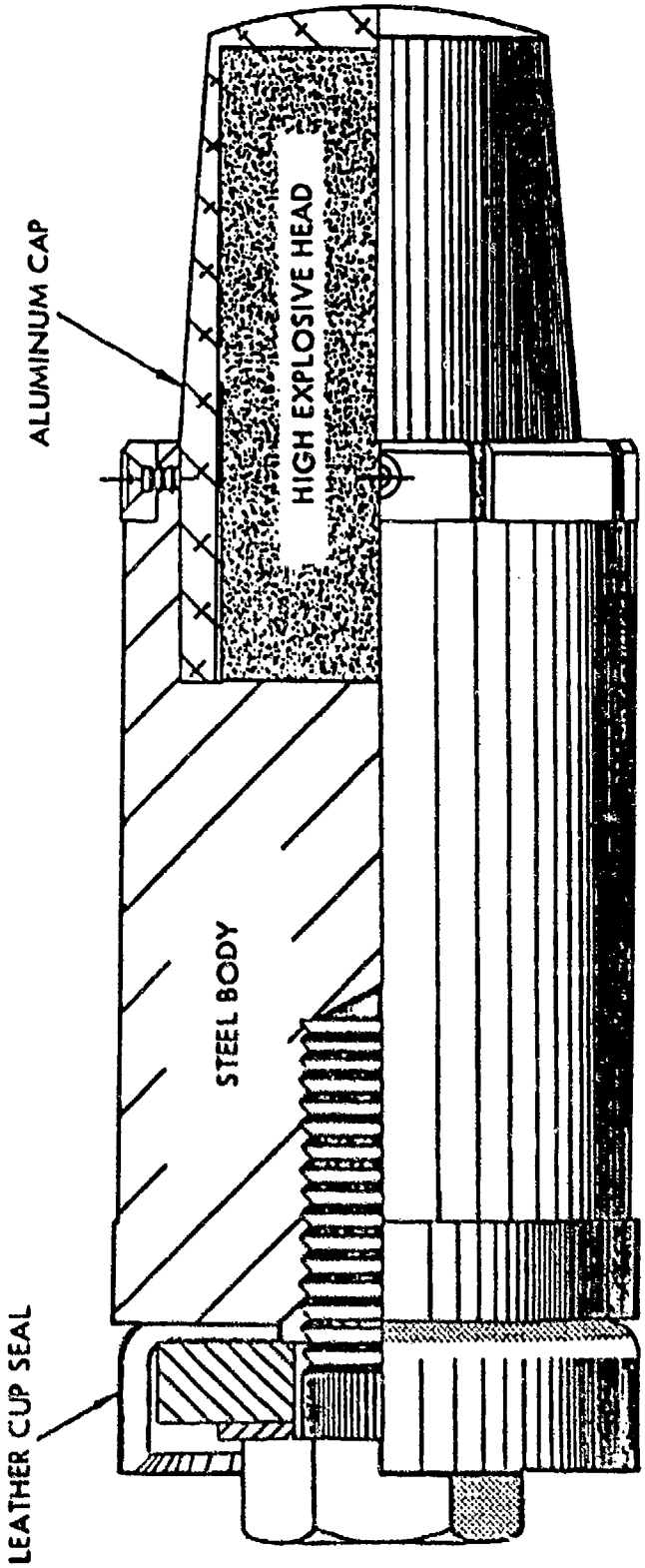


FIGURE 48.1. SUSAN PROJECTILE

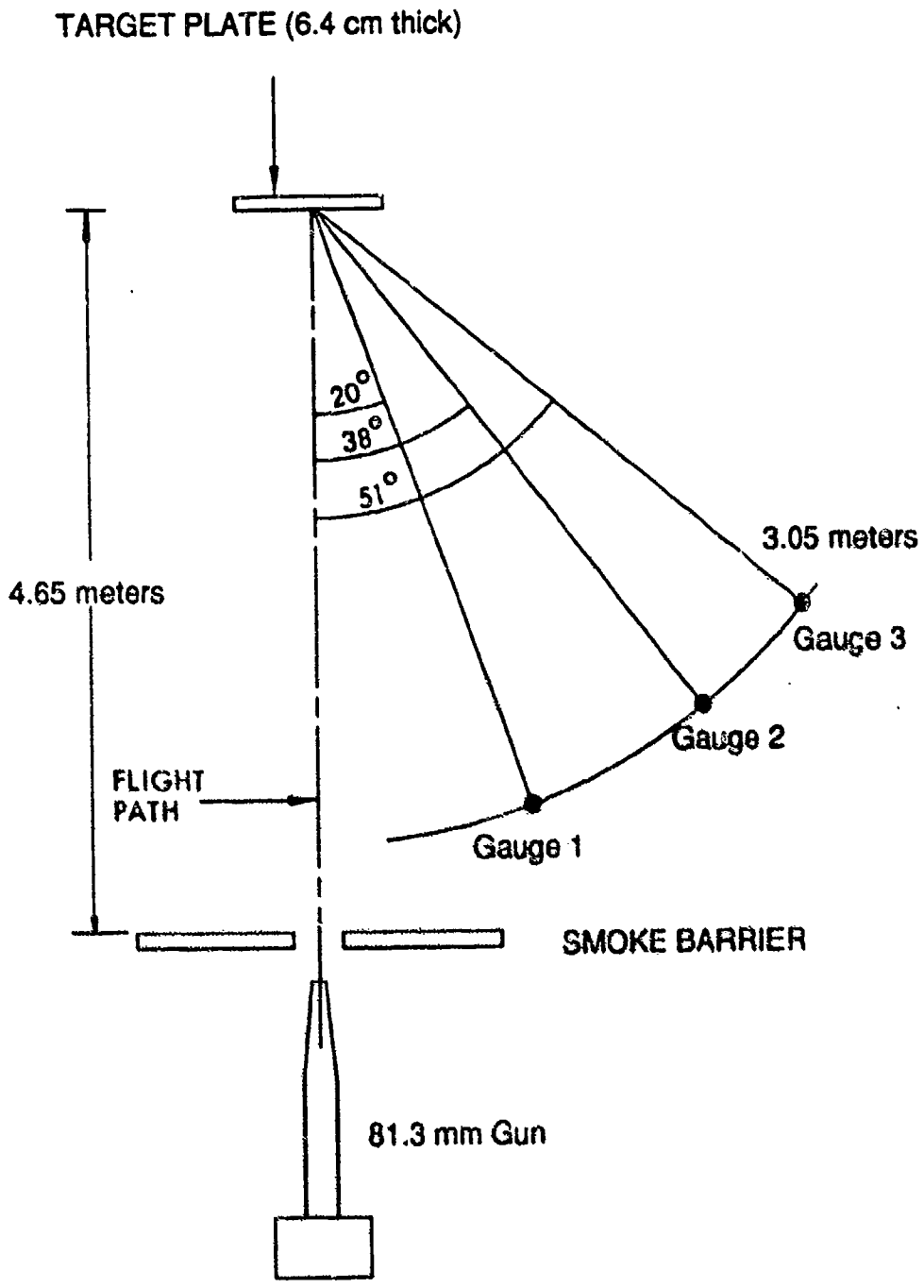


FIGURE 48.2. SCHEMATIC LAYOUT OF SUSAN TEST (TOP VIEW)

TEST 7(c)(ii) and TEST 7(d)(ii)

FRIABILITY TEST

49.1 INTRODUCTION

The friability test is used to establish the tendency of a compact EIDS candidate to deteriorate dangerously under the effect of an impact.

49.2 APPARATUS AND MATERIALS

(a) A weapon designed to shoot 18 mm diameter cylindrical test pieces at a velocity of 150 m/s.

(b) A Z30C 13 stainless steel plate, 20 mm thick with a front face roughness of 3.2 microns (AFNOR NF E 05-015 and NF E 05-016 standards).

(c) A 108 $\pm$ 0.5 cm^3 manometric bomb at 20°C.

(d) The sample of compact substance is cylindrical and of diameter 18 $\pm$ 0.1 mm. Its length is adjusted so as to obtain a mass of 9 $\pm$ 0.1 grams. The sample is brought up to and maintained at a temperature of 20°C.

(e) A fragment recovery box.

49.3 PROCEDURE

A naked cylindrical sample of 9 grams of a compact substance and 18 mm diameter is projected at a certain speed against a steel plate. The mass of fragments collected after the impact should be at least 8.8 grams. These fragments are fired in a manometric bomb. Ignition of the fragments in the bomb is obtained by a firing capsule consisting of a hot wire and 0.5 grams of black powder of average diameter 0.75 mm. The curve of pressure against time ($p = f(t)$) is recorded; this enables the curve $(dp/dt) = f'(t)$ to be constructed. On this curve, the maximum value of (dp/dt) is read off. Three tests are carried out with impact speeds as near as possible to 150 m/s. This enables the value of (dp/dt) corresponding with an impact speed of 150 m/s to be estimated.

49.4 CRITERIA AND METHOD OF ASSESSING RESULTS

If the average maximum (dp/dt) value obtained at a speed of 150 m/s is greater than 15 MPa/ms, the substance tested is not an EIDS and the result is noted as "+."

49.5 EXAMPLES OF RESULTS

TEST SUBSTANCE	RESULT	DATA REFERENCE
RDX/WAX/Graphite 95-5-0.5 pressed	+	FS/FE/8 2B/03/86/16
Plastic bonded explosive: 86% coarse HMX, 14% binder polyurethane	+	FS/FE/8 2B/03/83/01
Active nitrated bonded explosive 80% coarse (~1 mm) HMX, 20% binder	+	FS/FE/8 2B/03/85/01
Plastic bonded explosive: 86% medium (~0.5 mm) HMX 14% polyurethane binder	-	FS/FE/8 2B/03/86/07
Plastic bonded explosive: 86% medium and fine HMX, 14% HTPB binder	-	FS/FE/8 2B/03/85/21
Plastic bonded explosive: 42% fine HMX, 9% fine ammonium perchlorate, 19% aluminum, 30% binder (polyester + NC)	-	FS/FE/8 2B/03/84/04

All these substances are compact and cast (except when described as "pressed")

TEST 7(d)(i)

EIDS BULLET IMPACT

50.1 INTRODUCTION

The bullet impact test is used to evaluate the response of a possible EIDS explosive substance to the kinetic energy transfer associated with impact and penetration of a given energy source (a 12.7 mm projectile travelling at a specified velocity).

50.2 APPARATUS AND MATERIALS

50.2.1 Explosive test samples fabricated by normal techniques are employed. The samples should have a length of 20 cm and a diameter to allow a close fit into a seamless steel pipe having an inside diameter of 45 mm (± 10 percent variation), a wall thickness of 4 mm (± 10 percent variation), and a length of 20 cm. The pipes are closed with steel or cast iron end caps, torqued to 204 Newton-meter (N-m).

50.2.2 The bullet is a standard 12.7 mm armor-piercing bullet with a projectile mass of 0.046 kg, and is fired at the service velocity of about 820 ± 60 m/s from a 12.7 mm gun.

50.3 PROCEDURE

50.3.1 A minimum of six test articles (explosive substance in capped steel pipe) should be fabricated for the tests.

50.3.2 Each test article is positioned on a suitable pedestal at a convenient distance from the muzzle of the gun. Each test article is secured in a holding device upon its pedestal. This device should be capable of restraining the item against dislodgement by the bullet.

50.3.3 A test consists of the firing of one projectile into each test item. There should be at least three tests with the test article oriented such that its long axis is perpendicular to the line of flight (i.e., impact through the side of the pipe). There should also be at least three tests with the test article oriented such that its long axis is parallel to the line of flight (i.e., the impact will be through the end cap).

50.3.4 Remains of the test container are collected. Complete fragmentation of the container is indicative of explosion or detonation.

50.4 CRITERIA AND METHOD OF ASSESSING RESULTS

A substance which explodes or detonates in any trial is not an EIDS explosive and the result is noted as a "+."

50.5 EXAMPLES OF RESULTS

TEST SUBSTANCE	RESULT	DATA REFERENCE
COMPOSITION B	+	USA SOURCES
PBX-9502	–	

COMPOSITION B: melt cast material consisting of 60 percent RDX and 40 percent TNT

PBX-9502: pressed material consisting of 95 percent TATB and 5 percent KEL-F

TEST 7(e)

EIDS EXTERNAL FIRE TEST

51.1 INTRODUCTION

51.1.1 The external fire test is used to determine the reaction of an EIDS candidate explosive to external fire when it is confined.

51.2 APPARATUS AND MATERIALS

51.2.1 Explosive test samples fabricated by normal techniques are employed. The samples should have a length of 20 cm and a diameter to allow a close fit into a seamless steel pipe having an inside diameter of 45 mm (± 10 percent variation), a wall thickness of 4 mm (± 10 percent variation), and a length of 20 cm. The pipes are closed with steel or cast iron end caps, torqued to 204 N-m.

51.3 PROCEDURE

51.3.1 The experimental procedure is the same as for TEST 6(c) (see paragraph 44.3) except as noted in paragraph 51.3.2 below.

51.3.2 For substances, this test requires a minimum of five confined samples stacked horizontally and banded together. The test is conducted either on fifteen samples in one fire or on five samples in each of three fires. Color photographs are taken to document the condition of the samples after each test. Cratering and the size and location of confining pipe fragments are documented as an indication of the degree of reaction.

51.4 CRITERIA AND METHOD OF ASSESSING RESULTS

An explosive substance which detonates or reacts violently with fragment throw of more than 1 gram over more than 15 meters is not an EIDS explosive substance and the result is noted as a "+."

51.5 EXAMPLES OF RESULTS

TEST SUBSTANCE	RESULT	DATA REFERENCE
COMPOSITION B	+	USA SOURCES
PBX-9502	-	

COMPOSITION B: melt cast material consisting of 60 percent RDX and 40 percent TNT

PBX-9502: pressed material consisting of 95 percent TATB and 5 percent KEL-F

TEST 7(f)

EIDS SLOW COOKOFF TEST

52.1 INTRODUCTION

This is a test on a possible EIDS explosive substance. It is used to determine reaction to a gradually increasing thermal environment and the temperature at which such reaction occurs.

52.2 APPARATUS AND MATERIALS

52.2.1 Explosive test samples fabricated by normal techniques are employed. The samples should have a length of 20 cm and a diameter to allow a close fit into a seamless steel pipe having an inside diameter of 45 mm (± 10 percent variation), a wall thickness of 4 mm (± 10 percent variation), and a length of 20 cm. The pipes are closed with steel or cast iron end caps, torqued to 204 N.m.

52.2.2 The sample assembly is placed in an oven which provides a controlled thermal environment over a 40°C to 365°C temperature range and can increase the temperature of the surrounding oven atmosphere at the rate of 3.3°C per hour throughout the temperature operating range and ensure, by circulation or other means, a uniform thermal environment to the item under test. A means of relief should be provided for increased air pressure that is generated in the oven due to heating.

52.2.3 Temperature recording devices are used to monitor temperature at intervals of every ten minutes (or less); continuous monitoring is preferred. Instrumentation with an accuracy of ± 2 percent over the test temperature range is used to measure the temperature of:

(a) the air within the oven; and
(b) the exterior surface of the steel pipe.

52.3 PROCEDURE

52.3.1 The test item is subjected to a gradually increasing air temperature at a rate of 3.3°C per hour until a reaction occurs. The test may begin with the test item pre-conditioned to 55°C below the anticipated reaction temperature. The temperatures and elapsed test time are measured and recorded.

52.3.2 Color photographs are taken to document the condition of the unit and the test equipment before and after the test. Cratering and the size and location of any fragments are also documented as indications of the degree of reaction.

52.3.3 Three substance samples are subjected to this test.

52.4 CRITERIA AND METHOD OF ASSESSING RESULTS

After the completion of each test, the pipe or any fragments of pipe are recovered in the test area and examined for evidence of violent explosive reaction. Such evidence may include data on the number and size of recovered fragments of explosive or pipe, as well as the distance to which they were thrown. A substance which detonates or reacts violently (fragmentation of one or two end caps and fragmentation of the tube into more than three pieces) is not considered an EIDS and the result is noted as "+."

52.5 EXAMPLES OF RESULTS

TEST SUBSTANCE	RESULT	DATA REFERENCE
COMPOSITION B	+	USA SOURCES
PBX-9502	-	

COMPOSITION B: melt cast material consisting of 60 percent RDX and 40 percent TNT

PBX-9502: pressed material consisting of 95 percent TATB and 5 percent KEL-F

TEST 7(g)

1.6 ARTICLE EXTERNAL FIRE TEST

53.1 INTRODUCTION

The external fire test is used to determine the reaction of a possible Division 1.6 article to external fire as presented for transport.

53.2 APPARATUS AND MATERIALS

The experimental setup for this test is the same as for TEST 6(c) (see paragraph 44.2).

53.3 PROCEDURE

The procedure for this test is the same as for TEST 6(c) (see paragraph 44.3).

53.4 CRITERIA AND METHOD OF ASSESSING RESULTS

For assessing results, use the criteria as for TEST 6(c), paragraphs 44.4.2-44.4.4. If none of the events which would require the article to be confined to Divisions 1.1, 1.2, or 1.3 occur, then the article can be considered as a Division 1.6 article, and the result is noted as "-."

TEST 7(h)

1.6 ARTICLE SLOW COOKOFF TEST

54.1 INTRODUCTION

The 1.6 article slow cookoff is a test on a possible Division 1.6 article. It is used to determine the article's reaction to a gradually increasing thermal environment and the temperature at which such a reaction occurs.

54.2 APPARATUS AND MATERIALS

54.2.1 The test equipment consists of an oven which provides a controlled thermal environment over a 40°C to 365°C temperature range and can increase the temperature of the surrounding oven atmosphere at the rate of 3.3°C per hour throughout the temperature operating range, minimize hot spots, and ensure (by circulation or other means) a uniform thermal environment to the item under test. Secondary reactions (such as those caused by exudate and explosive gases contacting the heating devices) invalidate the test, but these can be avoided by providing a sealed inner container to surround articles shipped bare. A means of relief should be provided for the increased air pressure that is generated by the test due to heating.

54.2.2 Temperature recording devices (permanent record type) are used to monitor temperature continuously or at least every 10 minutes. Instrumentation with an accuracy of ± 2 percent over the test temperature range is used to measure the temperature at:

(a) the atmosphere air gap adjacent to the unit under test; and
(b) the exterior surface of the unit.

54.3 PROCEDURE

54.3.1 The test item is subject to a gradually increasing air temperature at a rate of 3.3°C per hour until unit reaction occurs. The test may begin with the test item preconditioned to 55°C below the predicted reaction temperature. Temperatures and elapsed test time are measured and recorded.

54.3.2 Color photographs are taken to document the condition of the unit and the test equipment before and after the test. Cratering and the size and location of any fragments are also documented as indications of the degree of reaction.

54.3.3 The test is conducted on two separate articles as presented for transportation.

54.4 CRITERIA AND METHOD OF ASSESSING RESULTS

If there is a reaction more severe than burning, the result is noted as "+" and the items are not classified as Division 1.6 articles. The energetic material may ignite and burn and the case may melt or weaken sufficiently to allow mild release of the combustion gases. Burning should be such that case debris and package elements stay in the area of the test except for case closures which may be dislodged by the internal pressure and thrown not more than 15 meters.

TEST 7(j)

1.6 ARTICLE BULLET IMPACT TEST

55.1 INTRODUCTION

The bullet impact test is used to evaluate the response of a possible Division 1.6 article to the kinetic energy transfer associated with the impact and penetration by a given energy source.

55.2 APPARATUS AND MATERIALS

A 12.7 mm gun is used to fire service 12.7 mm armor-piercing (AP) ammunition with a projectile mass of 0.046 kg and with standard propellant load. The gun should be fired by remote control and be protected from fragment damage by firing through a hole in a heavy steel plate. The firing gun muzzle should be at a range of 3-20 meters from the test item depending upon the explosive weight of the item. The test item should be secured in a holding device capable of restraining the item against dislodgement by projectiles. The test is recorded visually.

55.3 PROCEDURE

The test consists of subjecting an all-up (complete) EIDS loaded item to a three-round burst fired at 856 m/s velocity and 600 rounds/minute rate of fire. The test is repeated in three different orientations. In the appropriate orientation(s), the striking point on the test item for the multiple impact is selected so that the impacting rounds penetrate the most sensitive material(s), that is not separated from the main explosive charge by barriers or other safety devices. The degree of reaction is determined by post-test inspection of test film and hardware.

55.4 CRITERIA AND METHOD OF ASSESSING RESULTS

For an item to be considered as a Division 1.6 article, there should have been no detonation as a result of the tests. Reactions of the article identified as no reaction, burning, or deflagration are considered as negative test results and are noted as "-."

TEST 7(k)

1.6 ARTICLE STACK TEST

56.1 INTRODUCTION

The stack test is used to determine whether a detonation of a possible Division 1.6 article will initiate a detonation in an adjacent-like article, as offered for transport.

56.2 APPARATUS AND MATERIALS

The experimental setup is the same as for Test 6(b) (see para. 43.2) however without confinement. The donor article should be provided with its own means of initiation or a stimulus of similar power.

56.3 PROCEDURE

The experimental procedure is the same as for Test 6(b) (see para. 43.2). The test is to be conducted three times, unless a detonation of an acceptor is observed.

56.4 CRITERIA AND METHOD OF ASSESSING RESULTS

Fragment data (size and number of acceptor article fragments) damage to the witness plate and crater dimensions are used to determine whether or not any acceptor detonated. Blast data may be used to determine whether or not any acceptor has detonated. Blast data may be used to supplement this decision. For a Division 1.6 article it has to be demonstrated no propagation (detonation of acceptor) has occurred during the test.

Acceptor article response identified as no reaction, burning, or deflagration are considered as negative test results and noted as "-."

APPENDIX D

EIDS CAP TEST

The tests were conducted in accordance with Test 7(a) of the 1.6 Test Protocol for Composition B and PBX-9502. The protocol calls for the test to be repeated three times or until a detonation occurs. The following are the results which were obtained:

COMPOSITION B	2/3 detonated 1/3 misfire
PBX-9502	3/3 no reaction

AFX-920, AFX-930, and AFX-931 were tested in accordance with the protocol given in Appendix A, which calls for five tests for each material.

AFX-920	5/5 no reaction
AFX-930	5/5 no reaction
AFX-931	5/5 no reaction

APPENDIX E

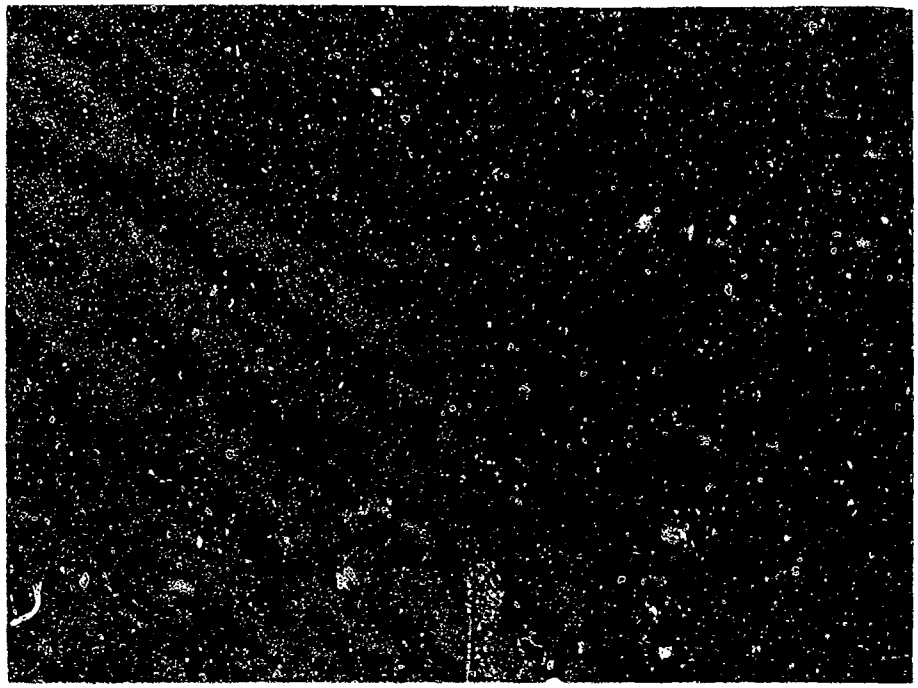
EIDS GAP TEST

The tests on Composition B and PBX-9502 were conducted in accordance with Test 7(b) of the 1.6 Test Protocol. The protocol calls for the test to be repeated three times or until a detonation occurs; the test is to be run at a gap of 70 mm. The following are the results which were obtained:

COMPOSITION B	3/3 detonated
PBX-9502	3/3 no reaction

Figure E-1 shows an "after" shot for PBX-9502. The Expanded Large Scale Gap Test (ELSGT) tube was not shattered, and the explosive material was recovered.

AFX-920, AFX-930, and AFX-931 were tested under the old protocol given in Appendix A. Under this protocol, the nominal 50 percent detonation point is determined. However, the reaction at 70 mm can be inferred from the data taken during the testing. In essence, in order to pass the 1.6 test protocol, the gap pressure required to cause detonation must be greater than approximately 35 kilobars for the ELSGT configuration ($P_{gap} > 35$ kilobars). The data for three materials (AFX-920, AFX-930, and AFX-931) indicate a gap pressure of approximately 60 kilobars--well above the level required for passing.



POST-TEST--GAP TUBE AND WITNESS PLATE

POST-TEST--EXPLOSIVE MATERIAL

FIGURE E-1. EXPANDED LARGE SCALE GAP TEST--PBX-9502

APPENDIX F

SUSAN TEST RESULTS

The SUSAN Test (Test 7(c)(i) of 1.6 Test Protocol) results included in this report and discussed in this appendix are based on three types of sources: (1) tests conducted in strict accordance with the 1.6 Test Protocol, (2) tests conducted with minor variations in the 1.6 Test Protocol but judged acceptable by competent national authorities, and (3) archival data, not conducted according to the 1.6 Test Protocol, but whose information has been interpreted and judged acceptable by competent national authorities.

Table F-1 summarizes the types of data used for the various substances discussed in Chapter 3.

Figure F-1 presents archival data for Composition B. Figure F-2 presents similar results for PBX-9502, while Figure F-3 presents results for AFX-920. Table F-2 presents the results obtained for the French samples tested under a cooperative arrangement with the French government. Table F-3 presents archival results for AFX-930 and AFX-931.

It must be remembered that all of the data presented in the tables and figures of this appendix have been scaled to sea level conditions; further, the pressures are for a range of 3.05 meters at sea level.

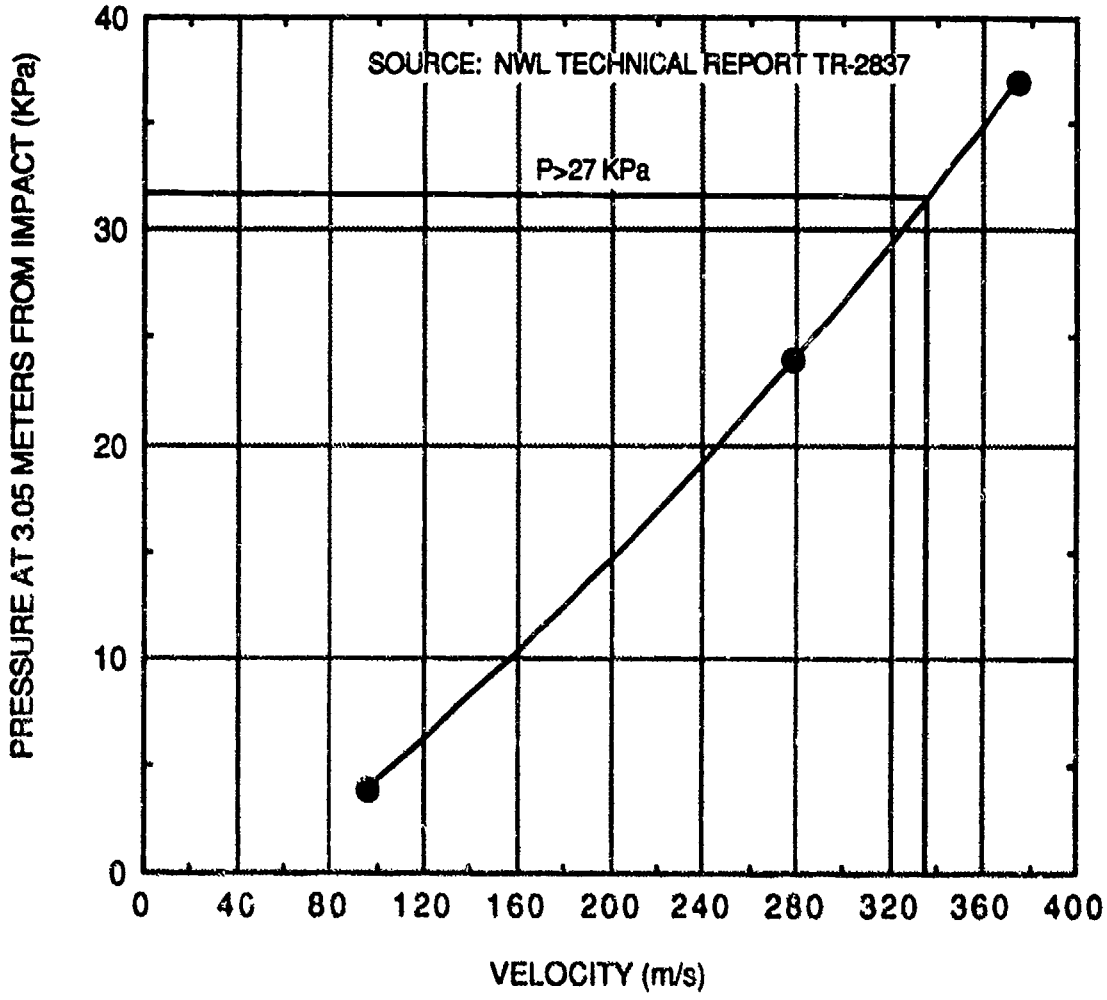


FIGURE F-1. ARCHIVAL COMPOSITION B SUSAN TEST DATA

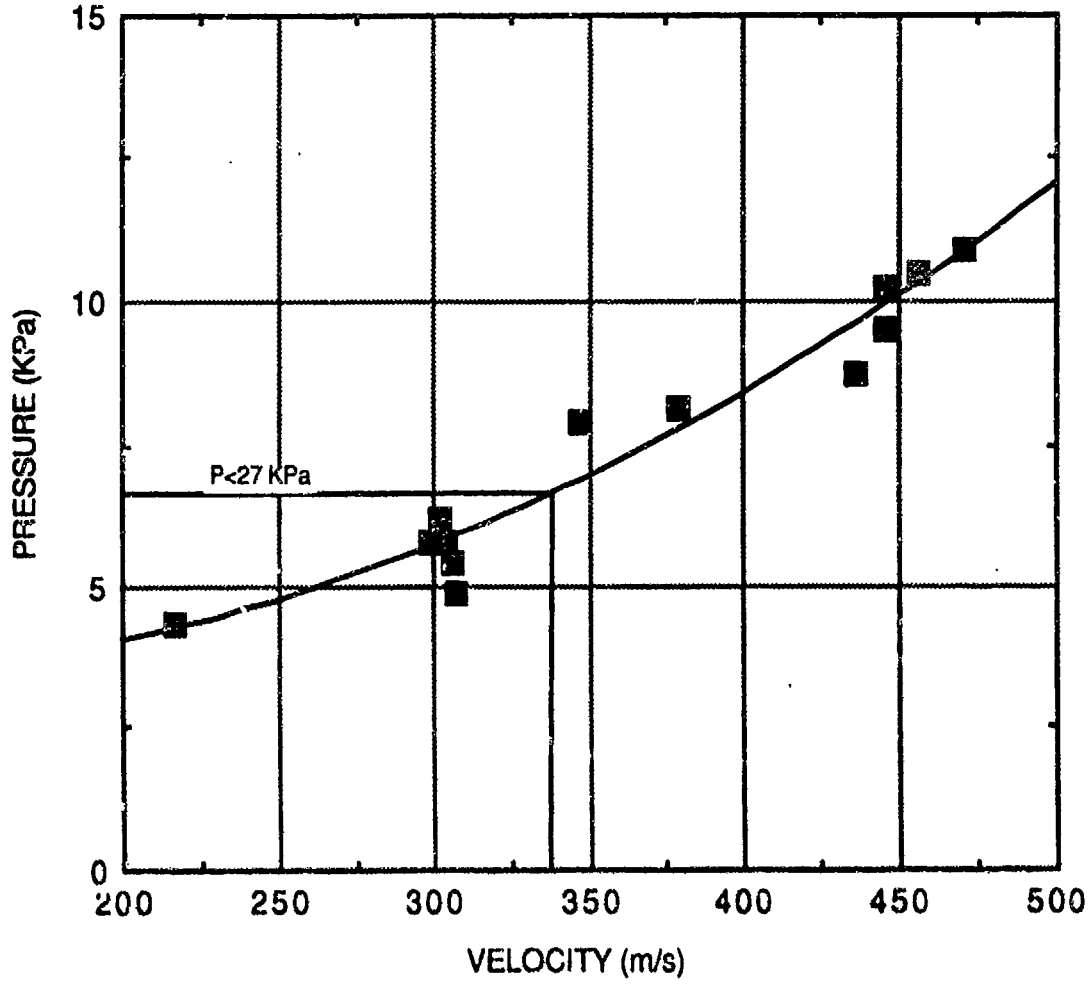


FIGURE F-2. SUSAN TEST DATA FOR PBX-9502

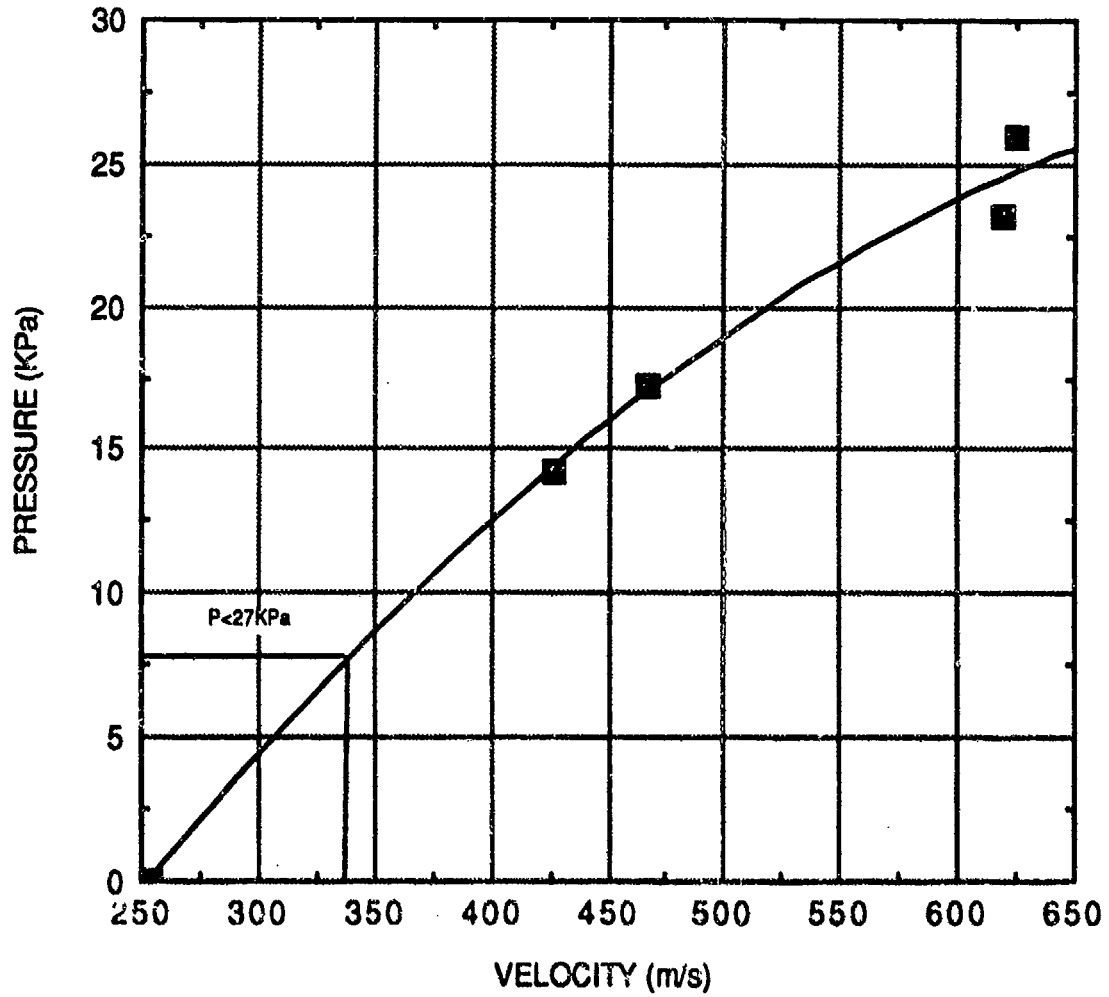


FIGURE F-3. SUSAN TEST RESULTS FOR AFX-920

TABLE F-1. TYPES OF SUSAN TEST INFORMATION

SUBSTANCE	TEST NUMBER
COMPOSITION B	3
PBX-9502	3
OCTORANE 86A	2
B3003	1
B3103	1
AFX-920	2
AFX-930	2

TEST NUMBER	TYPE OF TEST
1	Exact 1.6 Protocol
2	Modified 1.6 Protocol judged adequate by competent national authorities
3	Archival data interpreted by competent national authorities

TABLE F-2. SUSAN TEST RESULTS FOR FRENCH SUBSTANCES

MATERIAL	VELOCITY (m/s)	PRESSURE (KPa)			
		Gauge 1	Gauge 2	Gauge 3	Gauge 4
OCTORANE 86A	318	21.9	17.2	31.7	31.6
	318	19.4	23.7	31.7	22.6
	318	-	23.7	-	22.0
	324	21.3	20.0	32.4	22.0
	324	-	19.1	31.7	21.3
B3003	318	35.2	49.1	55.6	43.2
	318	37.0	50.1	53.8	41.9
	324	33.1	48.3	45.8	44.6
	331	41.3	50.1	54.7	41.2
	339	38.9	47.3	52.9	41.2
	346	40.7	49.1	57.3	42.5
	381	41.4	53.6	58.1	42.5
B3103	318	38.3	51.0	50.3	44.6
	318	35.9	38.2	48.5	43.2
	324	41.4	58.9	58.1	46.0
	331	31.6	47.3	47.6	41.2
	331	41.4	58.9	58.1	48.0
	476	41.4	58.9	58.1	52.5

TABLE F-3. AFX-930 AND AFX-931 SUSAN TEST RESULTS

MATERIAL	VELOCITY (m/s)	PRESSURE* (KPa)
AFX-930	322	11.5
	323	11.4
	321	9.1
AFX-931	266	16.3
	340	25.6
	345	26.1

*average of 4 gauges

APPENDIX G

EIDS BULLET IMPACT TEST

The tests were conducted in accordance with Test 7(d)(i) of the 1.6 Test Protocol. The protocol calls for six shots into the test hardware (three from the side and three from the end) unless a detonation occurs first. The following are the results which were obtained:

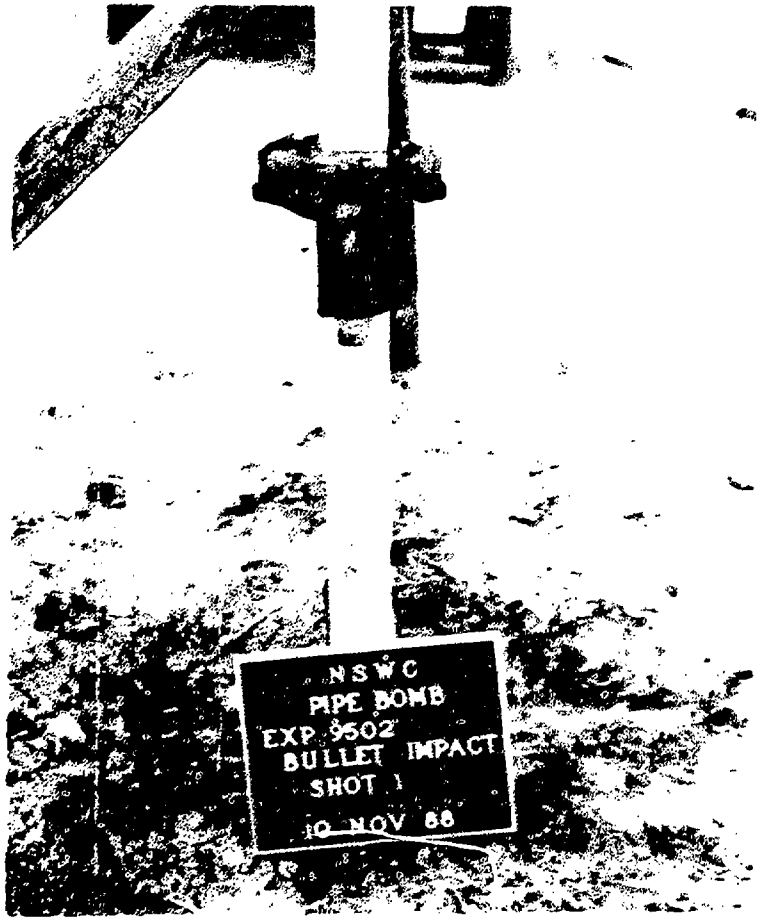
COMPOSITION B	detonated on first impact
PBX-9502	6/6 no reaction

The PBX-9502 specimens were subjected to a deliberate overtest. The protocol calls for a separate specimen for each shot; that is, each specimen is to be shot from only one orientation. Because the PBX-9502 rounds were in such good shape after the first bullet impact, it was decided to do a second impact on each specimen. Thus each specimen was impacted from both the side and the end.

Figures G-1 and G-2 are a sequence of four photographs of PBX-9502 undergoing tests. As can be seen, the first bullet impact simply punched a hole through the material. The second impact split the container, but caused no reaction.

AFX-920, AFX-930, and AFX-931 were also subjected to 1.6 Test Protocol. The following results were obtained:

AFX-920	6/6 no violent reactions (side impacts burned) (end impacts smoked)
AFX-930	6/6 no violent reactions (both orientations--mild burning)
AFX-931	6/6 no violent reactions (both orientations--endcap ruptures, vigorous burning)



BEFORE FIRST IMPACT

AFTER FIRST IMPACT

FIGURE G-1. PBX-9502 BULLET IMPACT (THROUGH SIDE)

BEFORE SECOND IMPACT

AFTER SECOND IMPACT

FIGURE G-2. PBX-9502 BULLET IMPACT (THROUGH END)

APPENDIX H

EIDS EXTERNAL FIRE TEST

The tests were conducted in accordance with Test 7(e) of the 1.6 Test Protocol. The protocol calls for either fifteen samples in one fire or five samples in each of three fires. If a detonation occurs on any test, the test may be stopped at that point.

The tests used a liquid fuel (JP-5) fire, as is allowed by the test protocol. Groups of five samples were utilized in all the tests. One deviation was made from the protocol. The tests on the PBX-9502 were only performed twice, instead of the three times as specified by the protocol. The following are the results which were obtained:

COMPOSITION B	3/5 detonated on first test 2/5 no reaction--fell into fire pit Average Fire Temperature: 843°C Time of Reaction: 239 seconds
PBX-9502	4/5 no reaction--fell into fire pit 1/5 expelled end cap <15 meters and burned Average Fire Temperature: 803°C Time of reaction: 652 seconds
	3/5 no reaction--fell into fire pit 2/5 deflagrated; pieces expelled <15 meters Average Fire Temperature: 998°C Time of Reaction: 982 seconds

Figure H-1 is a set of before and after photographs for the first PBX-9502 test. As can be seen, four samples were recovered intact; one had a ruptured end cap. Figures H-2, H-3, and H-4 present the temperature-time profiles recorded within the fires on each test. On the first test of the PBX-9502, the reaction was so mild that one thermocouple continued operating until the flame was extinguished. This can be seen in Figure H-3.

In addition to these test data, data were taken on AFX-920, AFX-930, and AFX-931. This information was taken under the procedures of TB 700-2, which did not require either multiple test units or multiple tests.

AFX-920 was tested using wood soaked with diesel fuel as the fire source. The fire reached a temperature of 1080°C. Approximately 4 minutes after ignition, an end cap was expelled and the remainder of the test item fell into the fire. A portion of the explosive filler was ejected approximately 6 meters from its original location.

AFX-930 was tested on a windy day, using wood soaked in kerosene. Because of the wind, temperature fluctuations occurred. About 150 seconds after exceeding an air temperature of 540°C, an endcap ruptured, expelling the energetic material 2 meters where it burned mildly to completion. The AFX-931 test was performed on a windless day. At 260 seconds after exceeding an air temperature of 540°C, the endcap ruptured, expelling the energetic material in three pieces. One piece was propelled about 42 meters where it burned mildly. Another landed about 12 meters away, while the majority of the charge burned mildly to completion about 4 meters from its original position. Judgement by competent national authority was that this constituted a "passing" reaction.

PRE-TEST--PBX-9502

POST-TEST--PBX-9502

FIGURE H-1. EIDS EXTERNAL FIRE TEST: PBX-9502

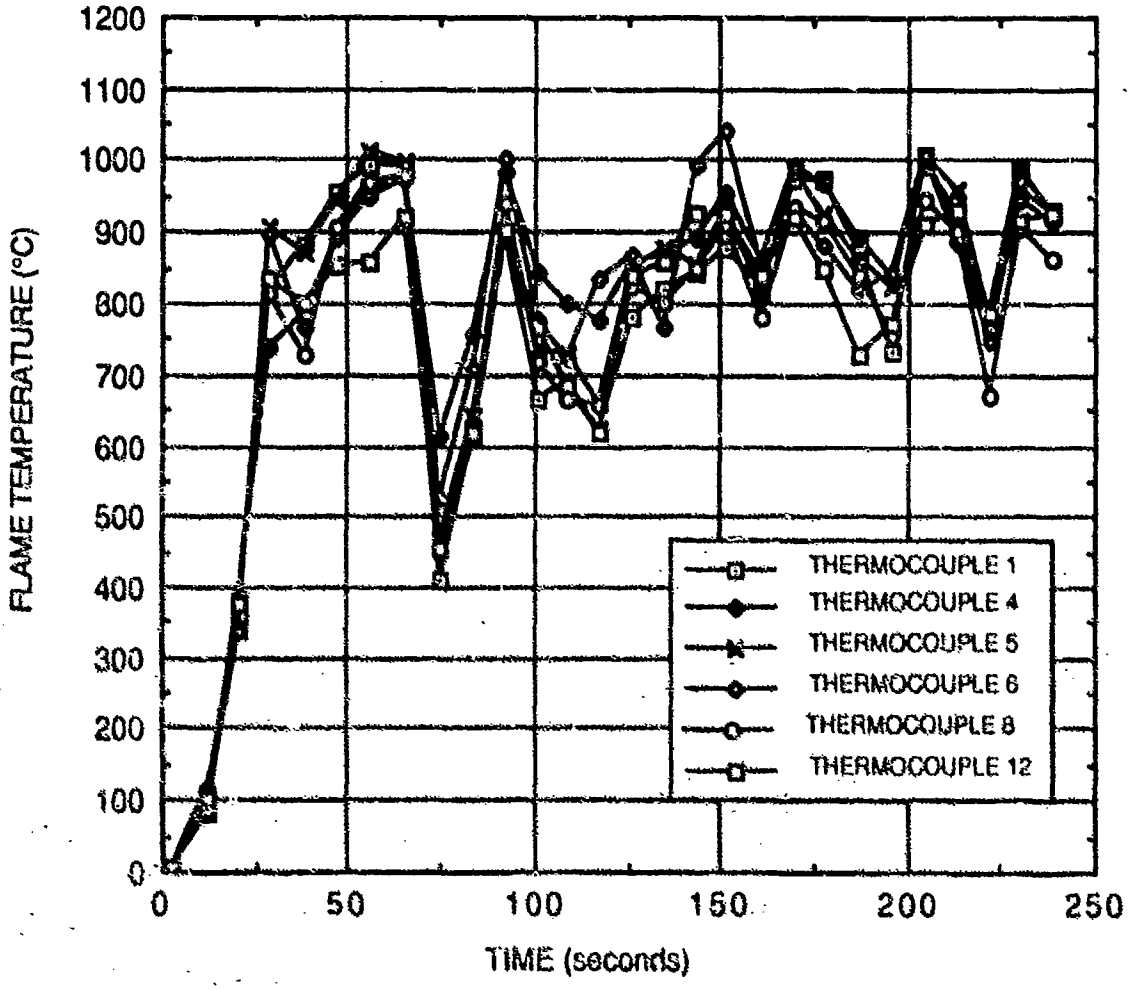


FIGURE H-2. COMPOSITION B

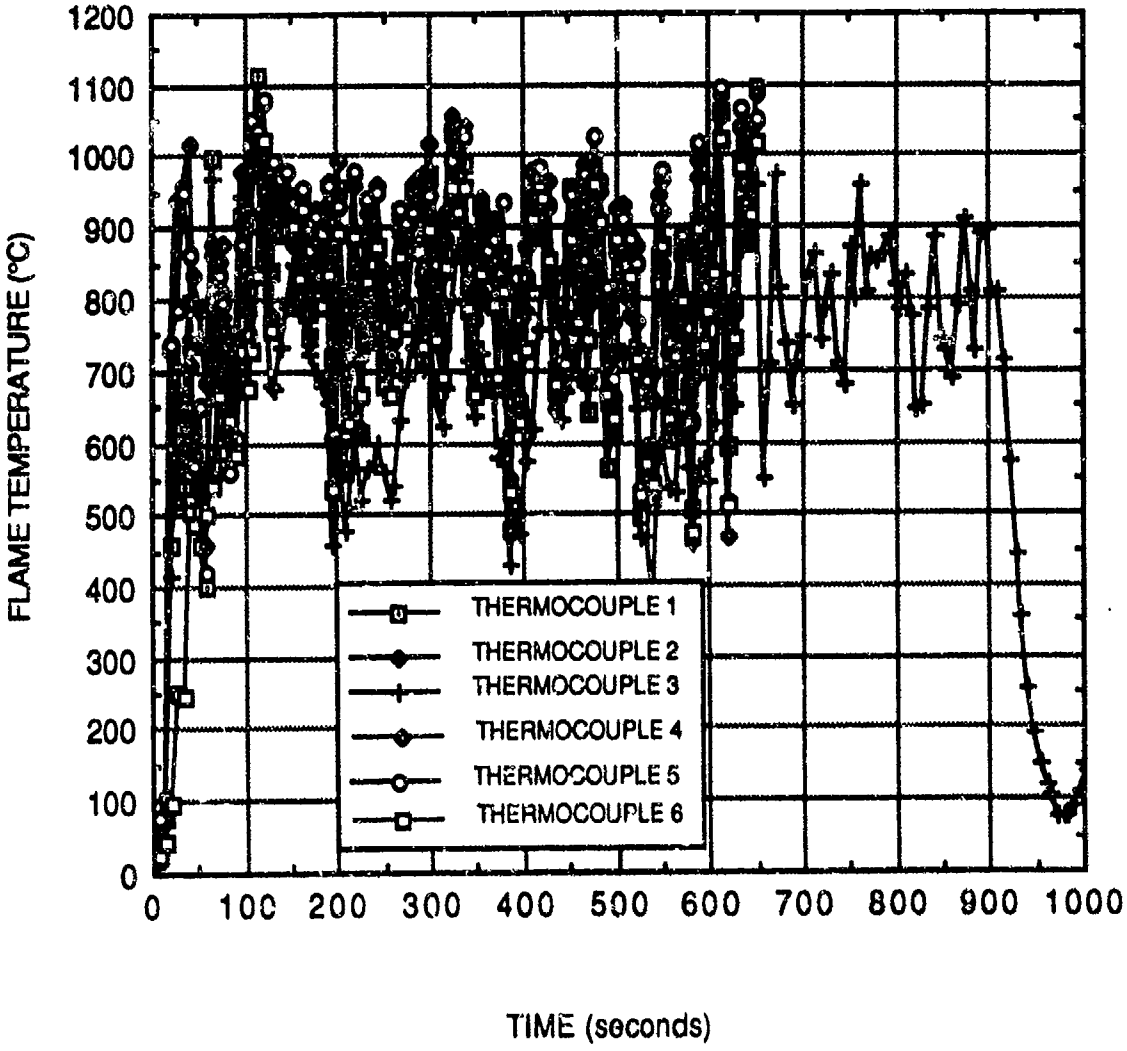


FIGURE H-3. PBX-9502: TEST 1

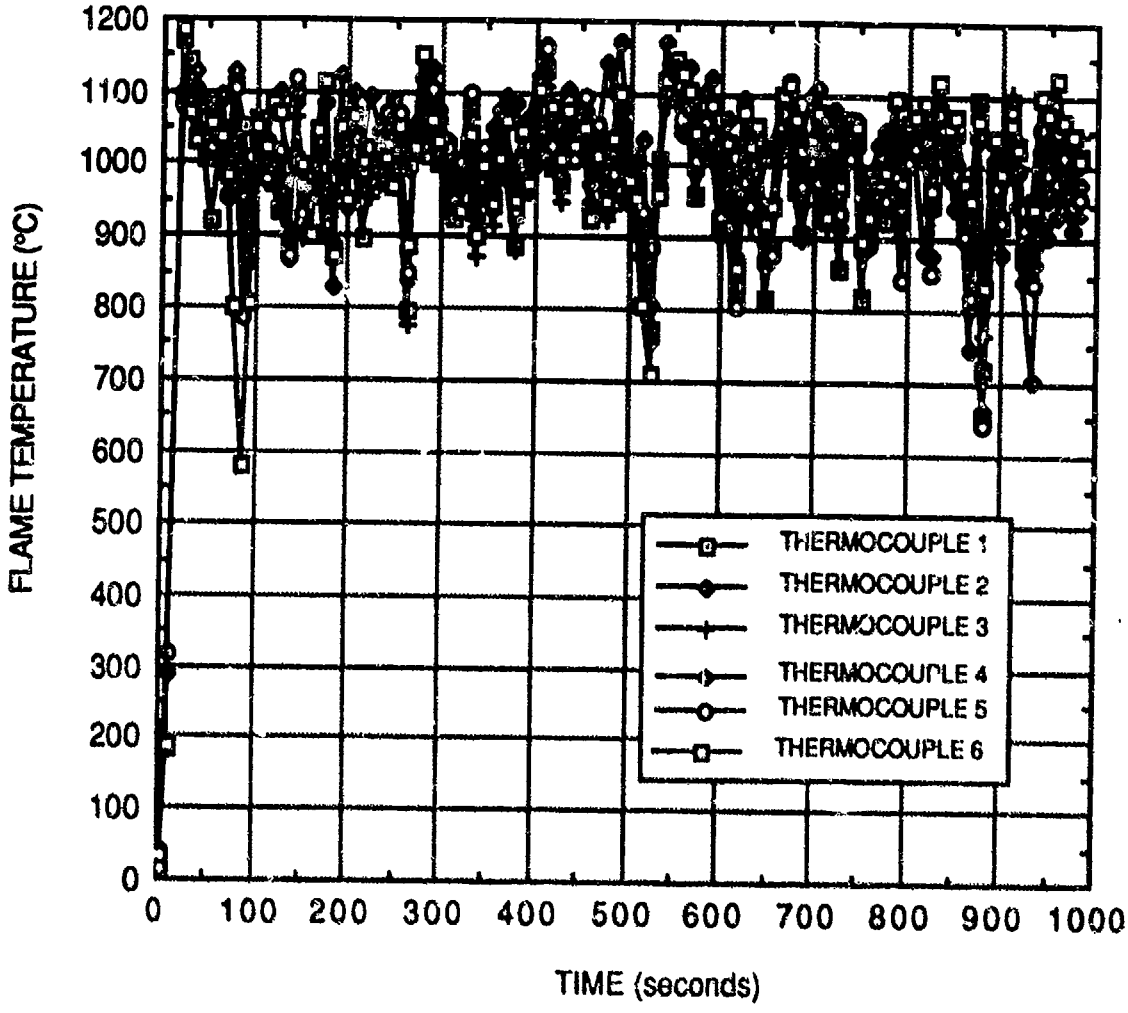


FIGURE H-4. PBX-9502: TEST 2

APPENDIX I

EIDS SLOW COOKOFF TEST

The tests were conducted in accordance with Test 7(f) of the 1.6 Test Protocol. The protocol calls for a sample to be placed into an oven and the temperature raised at a rate of 3.3°C per hour. The test is repeated on three samples. If a detonation occurs on any test, no further tests are required.

Figure I-1 is a set of before and after photographs for the Composition B tests. As can be seen, both samples detonated, destroying the ovens. A different configuration of oven was used in the testing of the PBX-9502. These differences have been shown to not affect the results. Figure I-2 shows photographs of this type of arrangement. Figure I-3 shows five temperature-time profiles obtained for one of the Composition B samples (note: all of the measuring points were on the surface of the test specimen). Figures I-4 to I-6 show the results obtained for the PBX-9502 specimens. The fact that there is little spread in the apparent width of the lines reflects the uniformity of the heating rate.

The following are the results which were obtained:

COMPOSITION B	2/2 detonated
PBX-9502	3/3 no violent reaction

Composition B detonated 26.5 hours after heating began. The reaction in one oven triggered a reaction in the other. The temperatures at the time of reaction were 171.5°C and 170.9°C, respectively. On the three PBX-9502 tests, reactions occurred at the following times and temperatures:

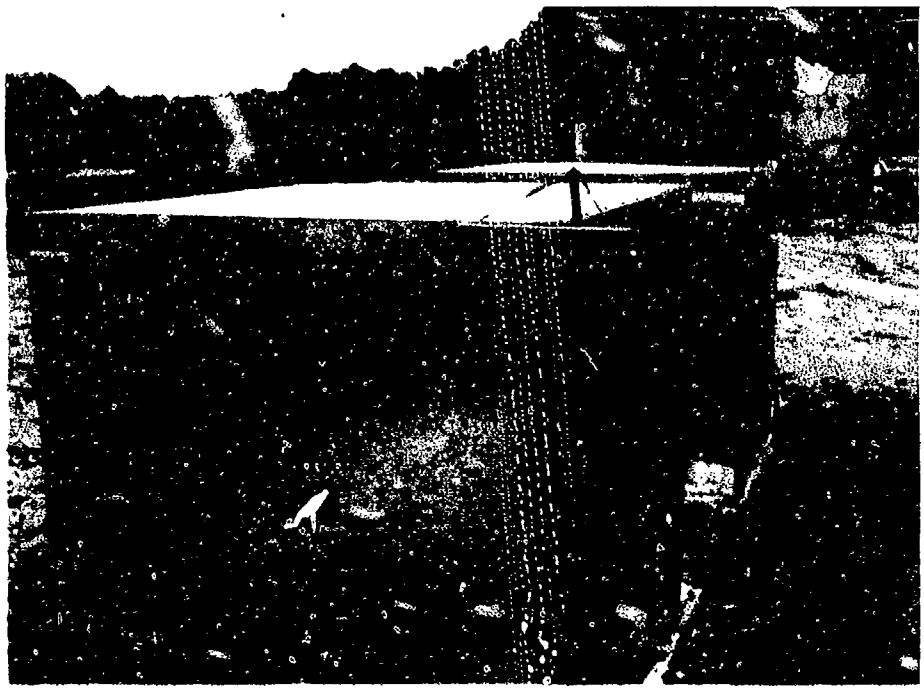
48.00 hours	252.5°C
56.75 hours	220.1°C
43.58 hours	155.1°C.

In each of these cases, the reaction was a mild pressure rupture, with little or no damage to the oven.

In addition to these test data, archival information was available on AFX-920, AFX-930, and AFX-931.

AFX-920	3/3 mild pressure burst (temperature of approximately 160°C on each test)

AFX-930	2/2 mild pressure burst--endcaps expelled about 2 meters--burned to completion (temperature of between 180°C to 190°C on each test)
AFX-931	2/3 mild reaction--endcaps expelled short distance--burned to completion 1/3 deflagration--endcaps ejected; end of pipe belled during the pressure rupture (temperature between 170°C and 180°C on each test)

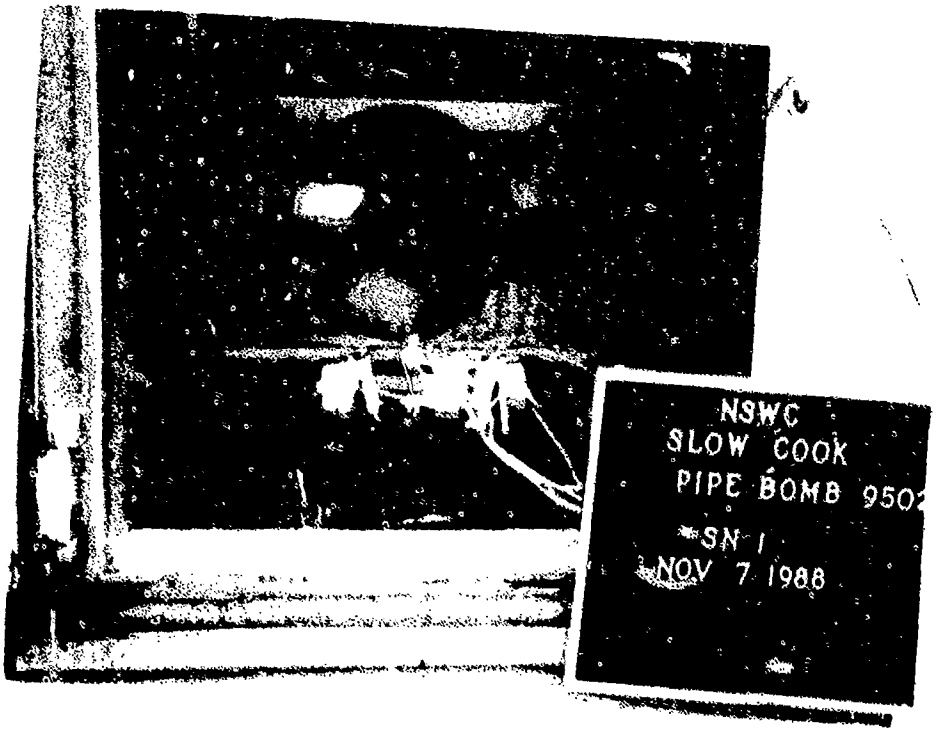


PRE-TEST

POST-TEST

FIGURE I-1. EIDS SLOW COOKOFF TEST: COMPOSITION B

EXTERNAL VIEW OF OVEN



TEST SAMPLE WITHIN OVEN

FIGURE I-2. EIDS SLOW COOKOFF TEST: PBX-9502

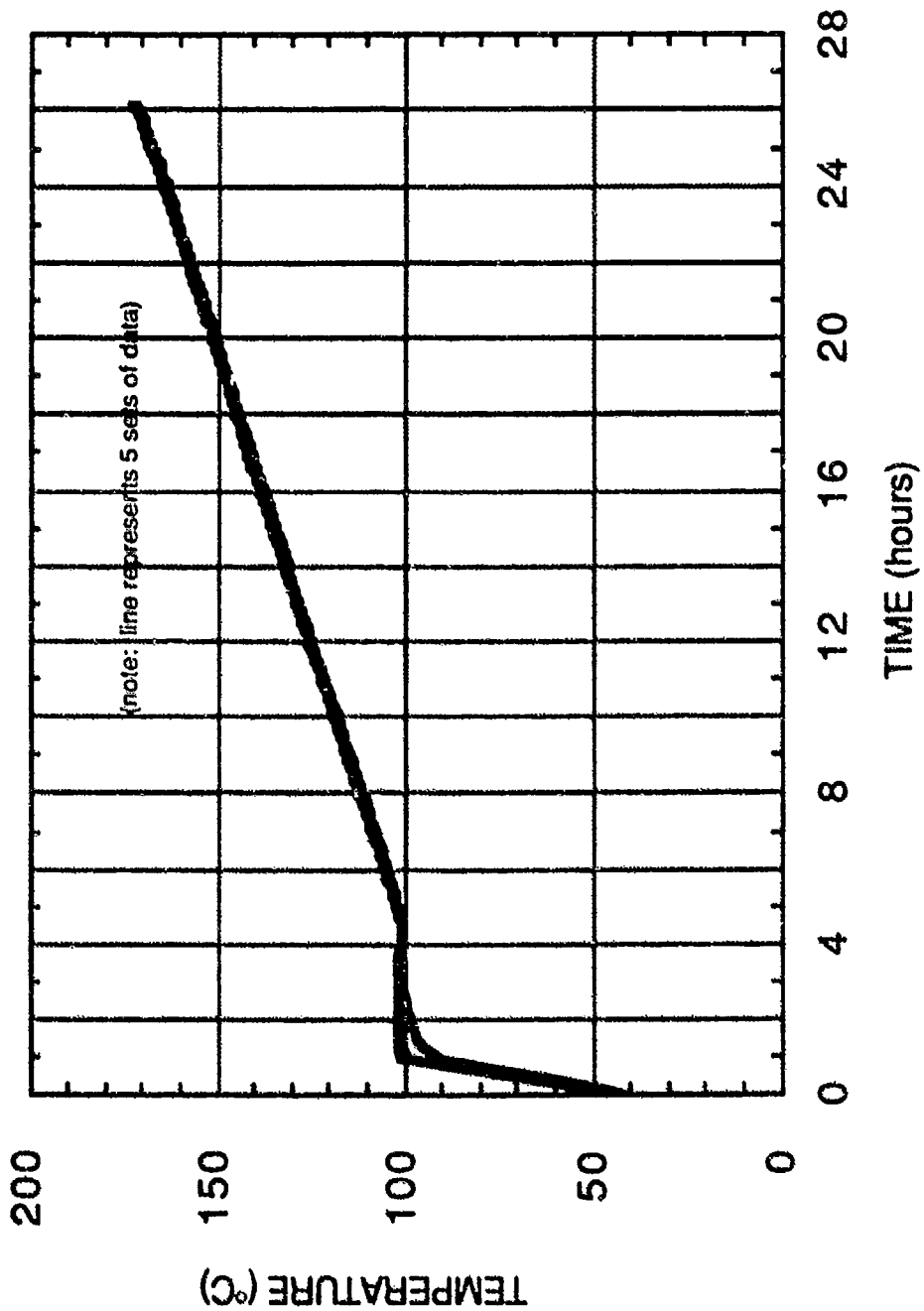


FIGURE I-3. SLOW COOKOFF OF COMPOSITION B

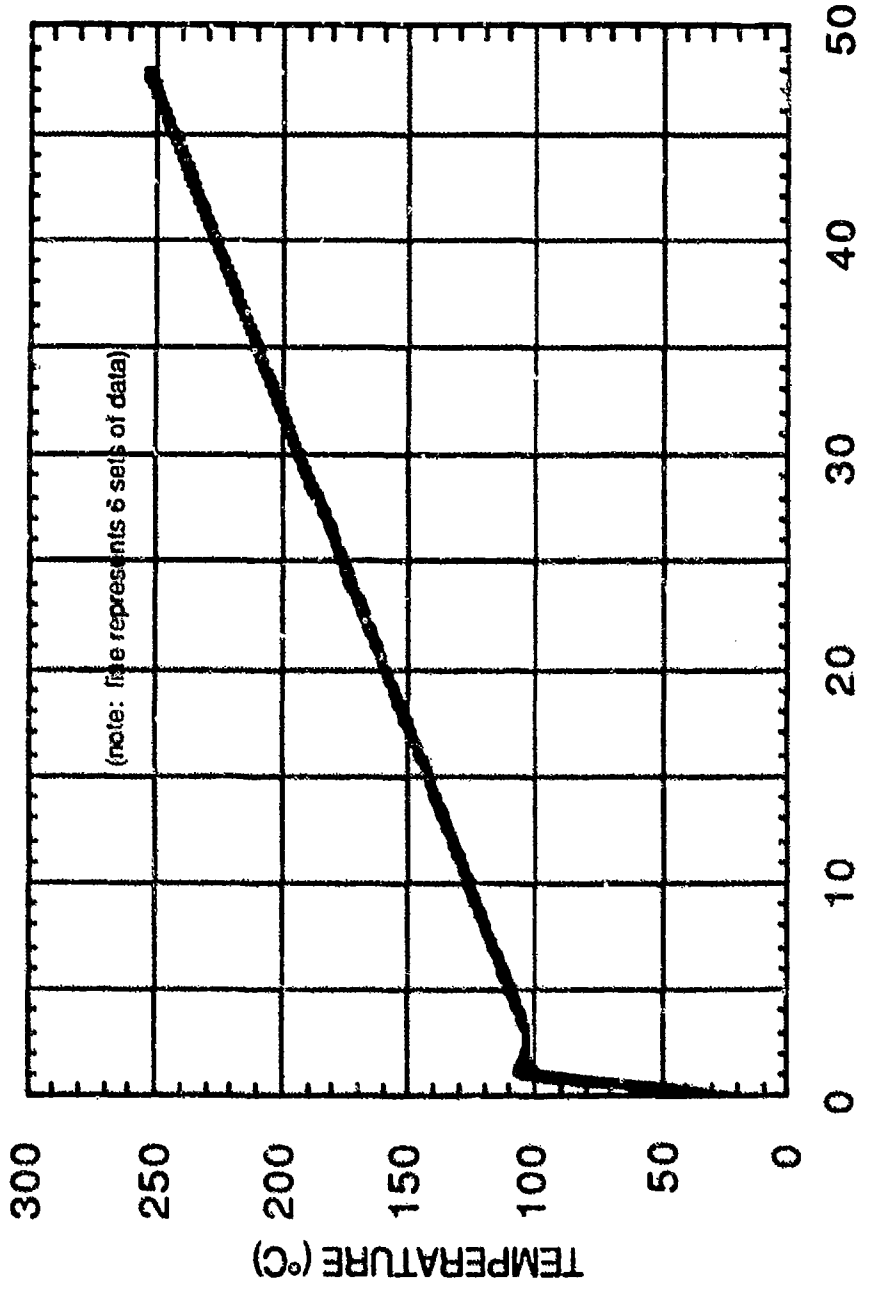


FIGURE I-4. SLOW COOKOFF OF PBX-9502

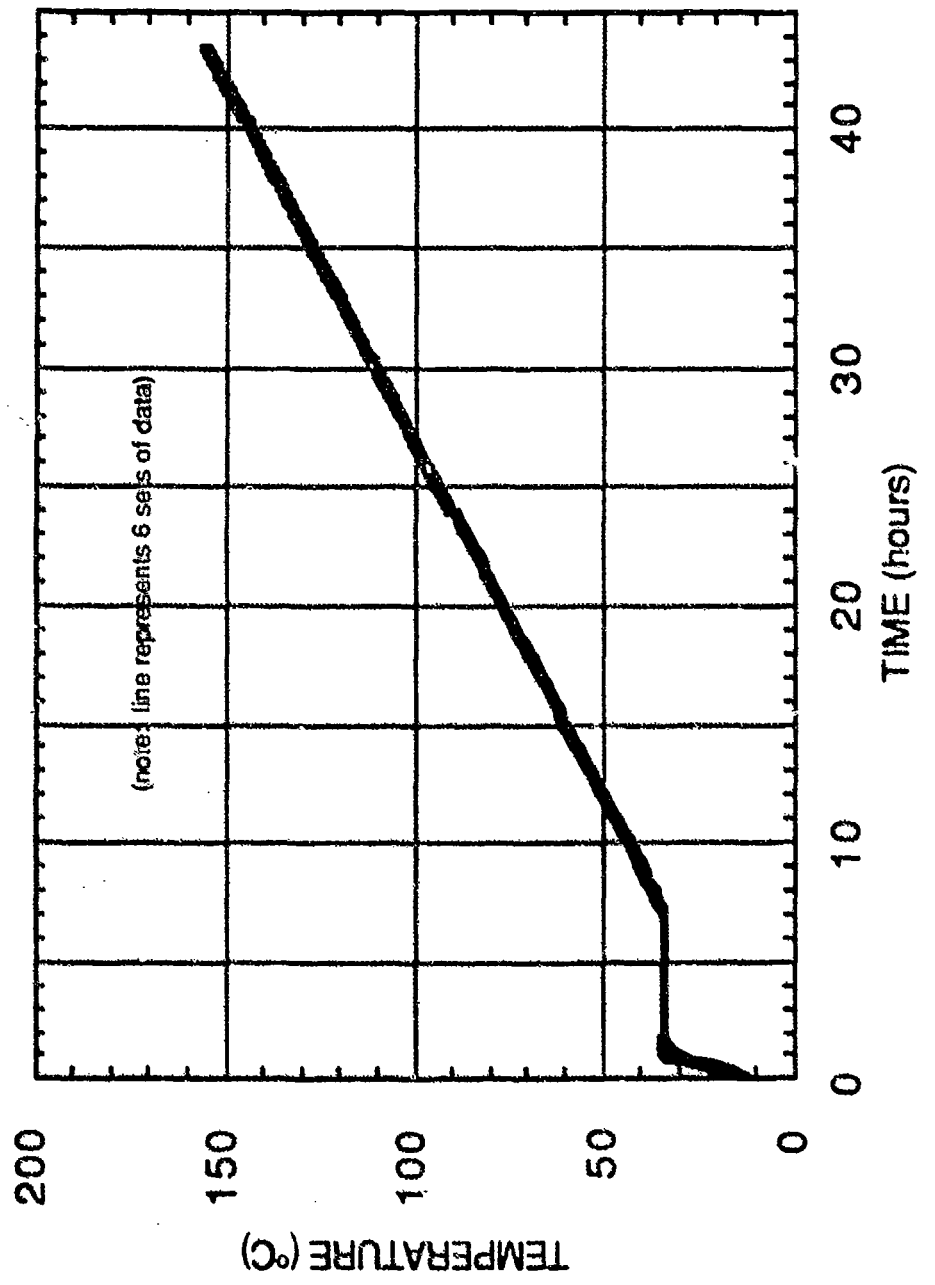


FIGURE I-5. SLOW COOKOFF OF PBX-9502

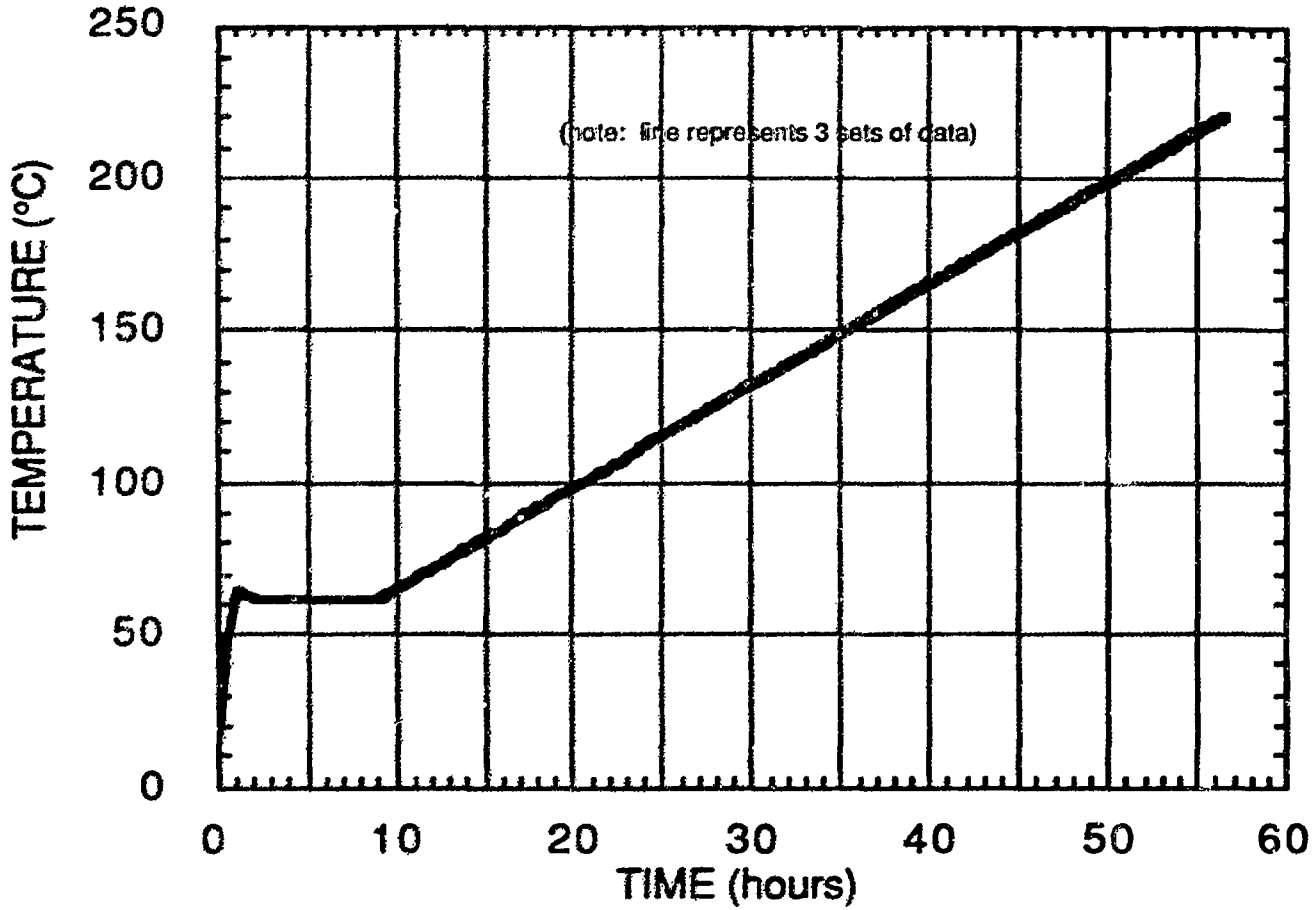


FIGURE I-6. SLOW COOKOFF OF PBX-9502

DISTRIBUTION

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A brief history of Class/Division 1.5/1.6 is presented. The protocol which has been developed and approved by the United Nations for testing these materials is given and discussed. The results of testing to determine if certain substances are Extremely Insensitive Detonating Substances (EIDS) is presented. The calibration of the Expanded Large Scale Gap Test (ELSGT), one of the tests for an EIDS, is also presented.

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